AUTOMOBILE ENGINEER

OCTOBER 1961

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it will be sure to have the most
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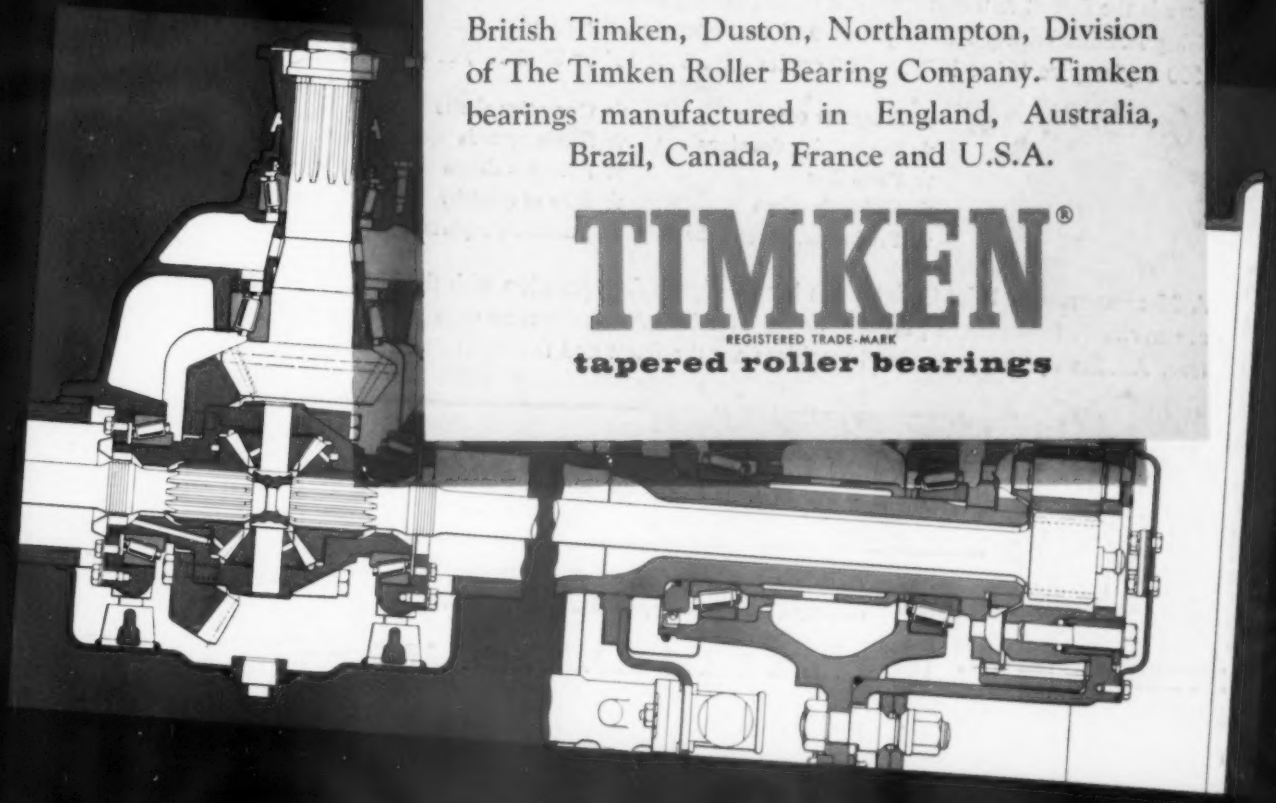
Timken tapered roller bearings.

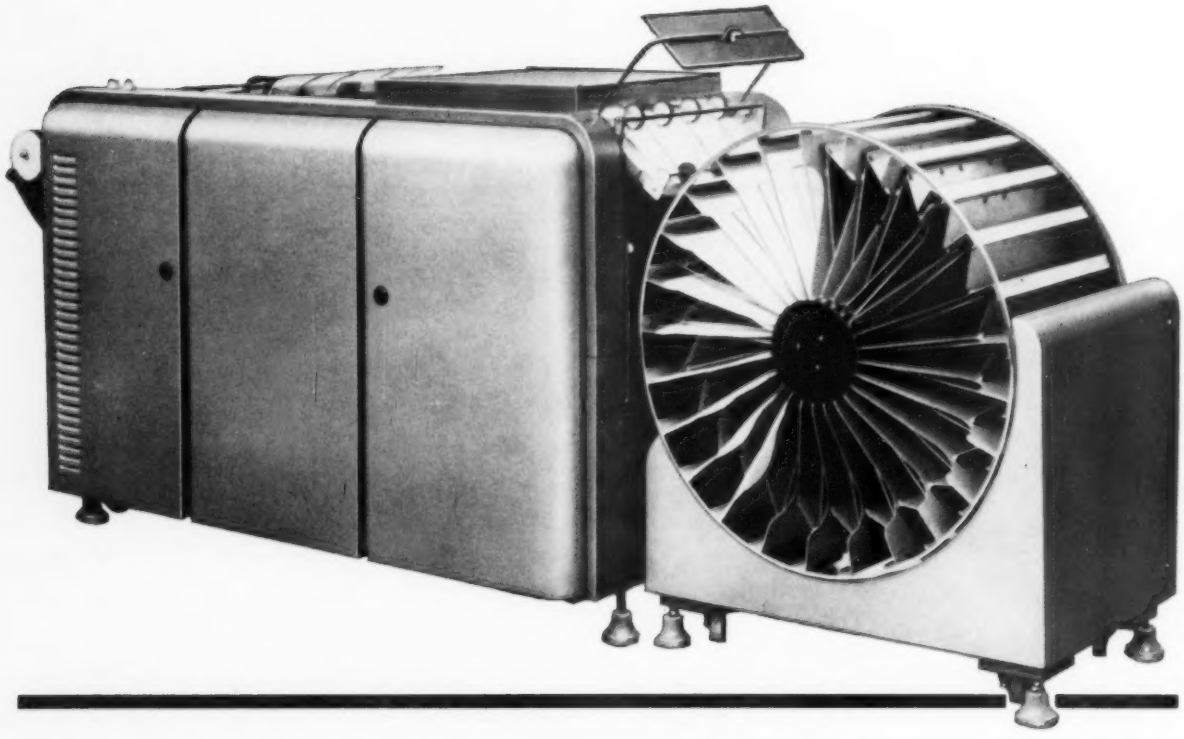
British Timken, Duston, Northampton, Division of The Timken Roller Bearing Company. Timken bearings manufactured in England, Australia, Brazil, Canada, France and U.S.A.

TIMKEN®
REGISTERED TRADE-MARK
tapered roller bearings



One operator . . . one machine . . .

3000 dyeline prints an hour!



Here is the fastest automatic dyeline photoprinting machine in Britain: the ILFORD Azoflex Model 155. Using Azoflex Ninety Ninety paper, and one operator, the Azoflex Model 155 can produce every hour 1500 copies (size 13″ × 16″) or 3000 copies (size 8″ × 13″ or 8″ × 10″) of the following:

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- ★ **Parts lists**
- ★ **Orders/invoices**
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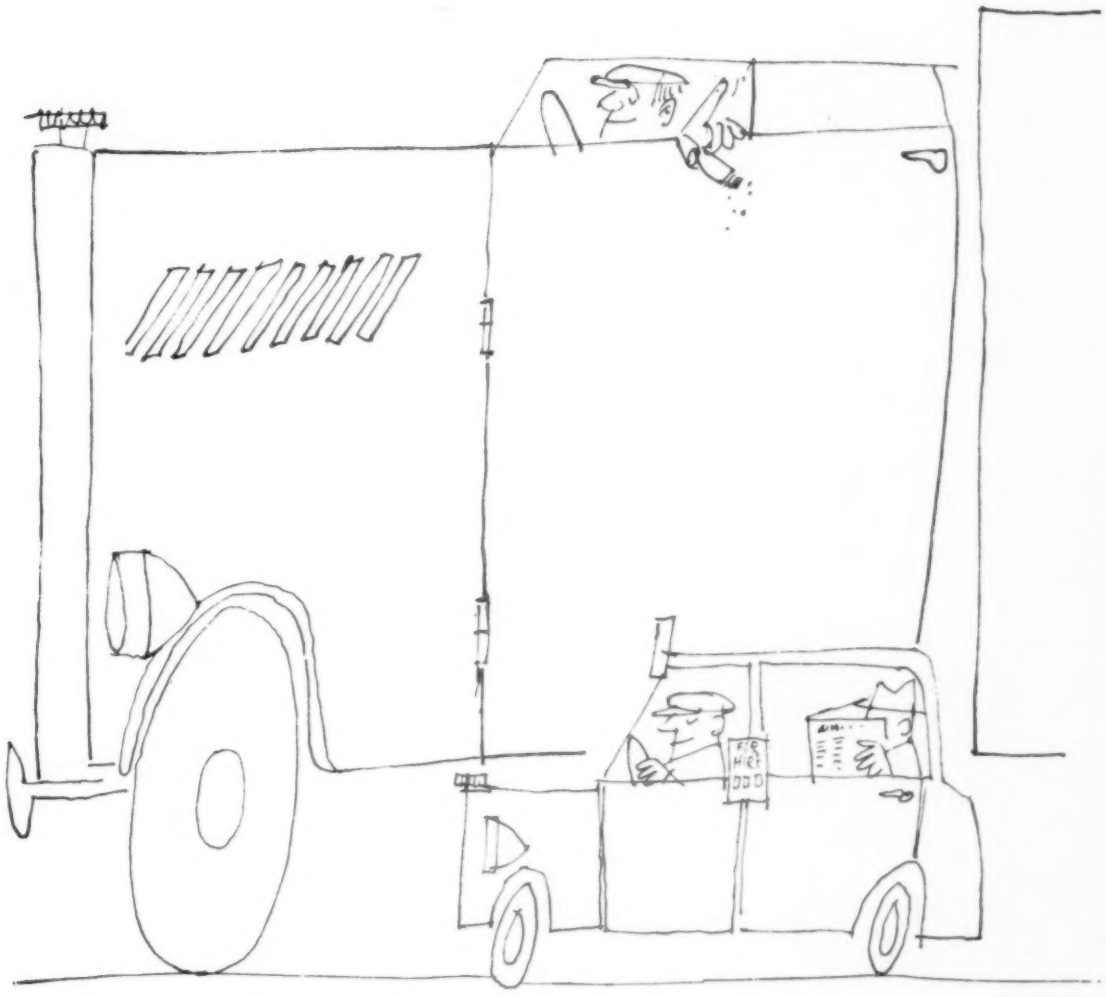

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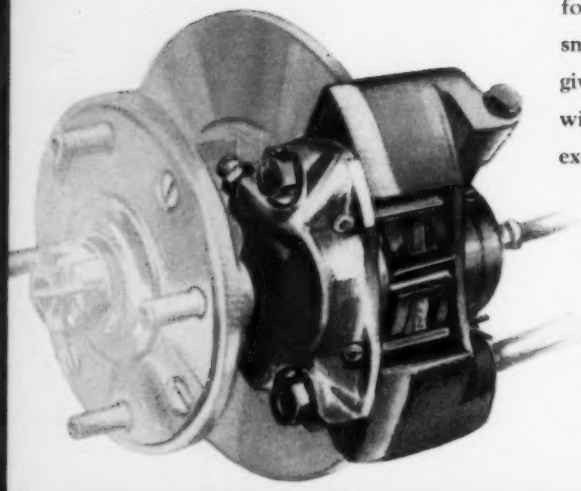

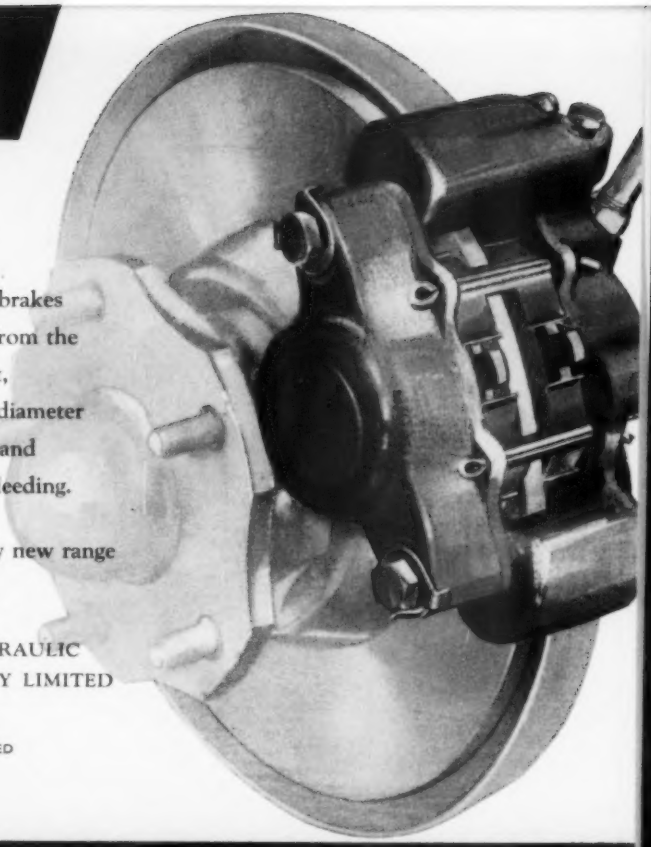

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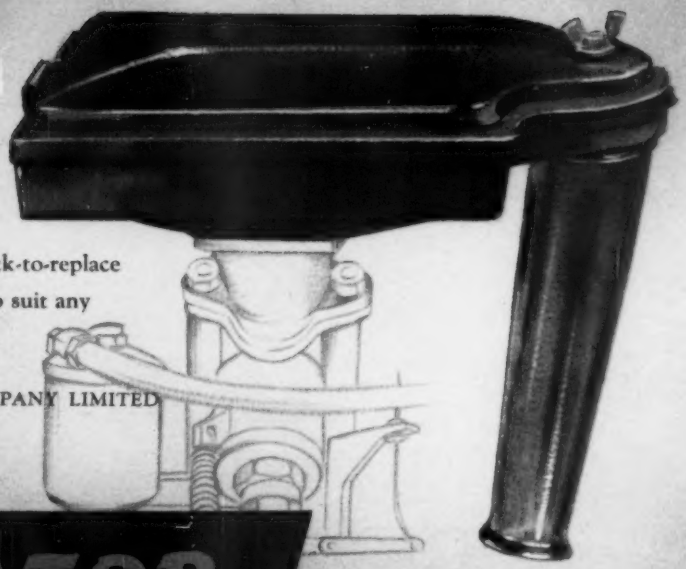

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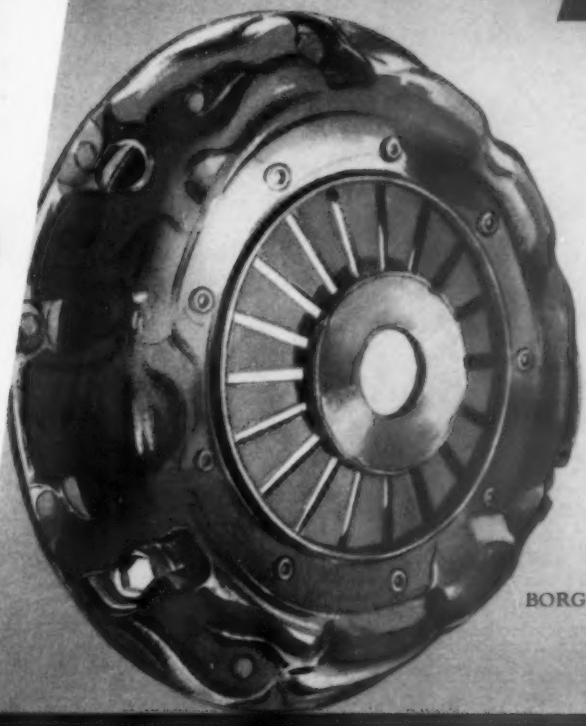

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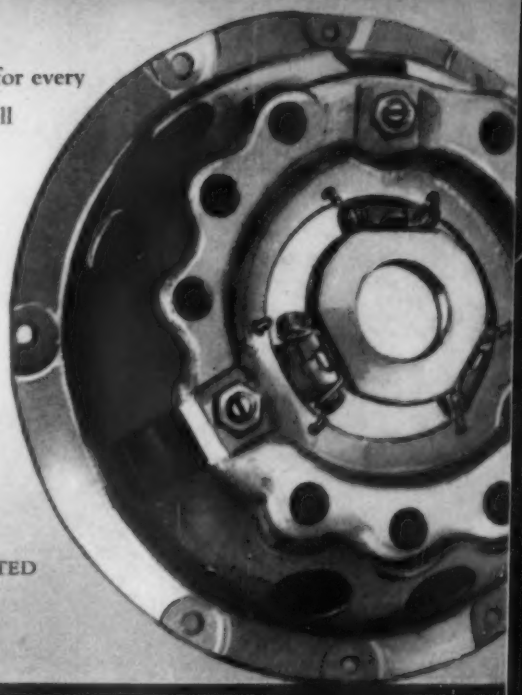

THE MOTOR SHOW BY MEMBERS OF

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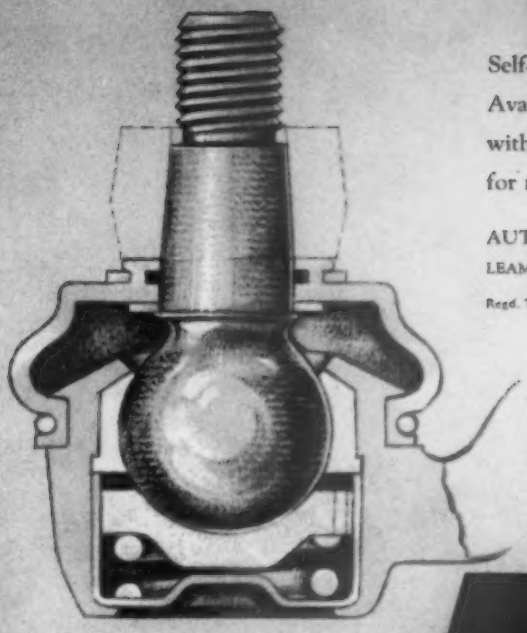

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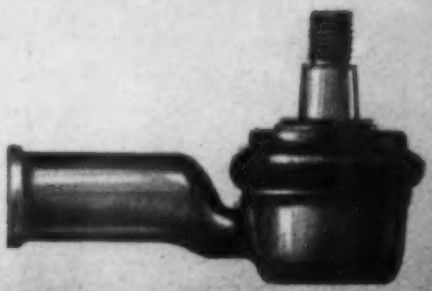

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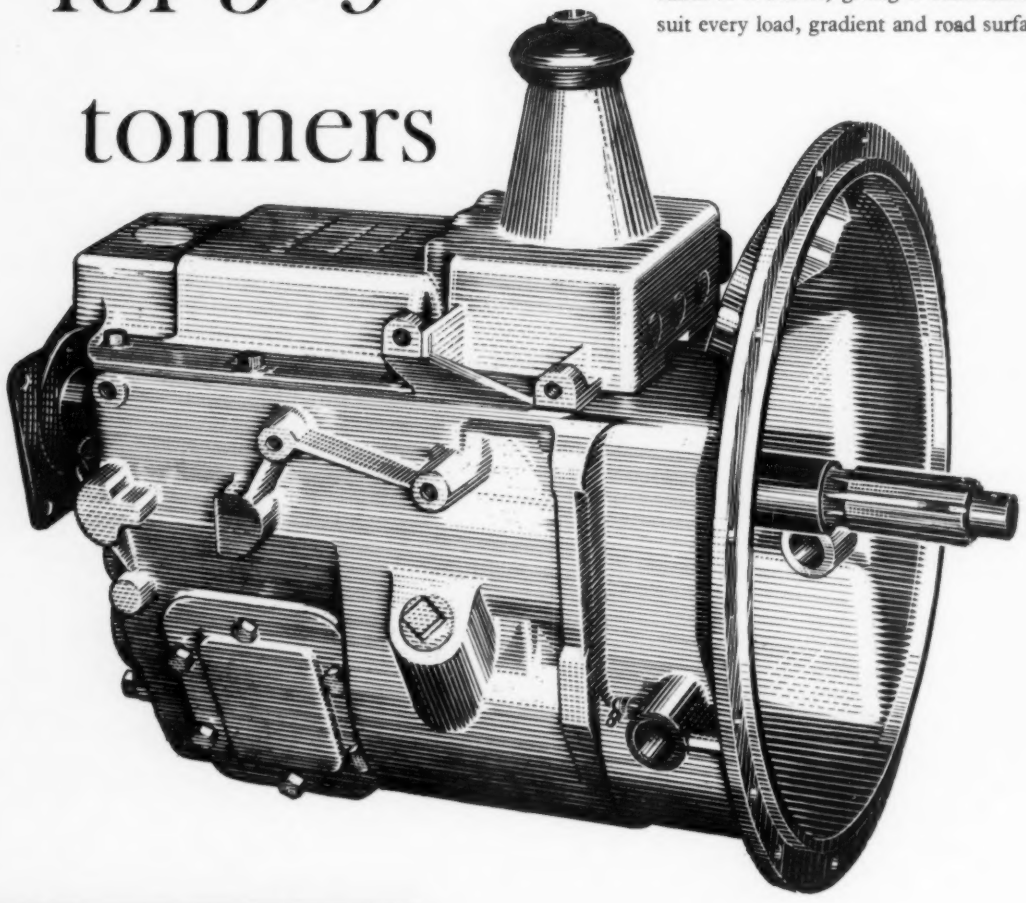

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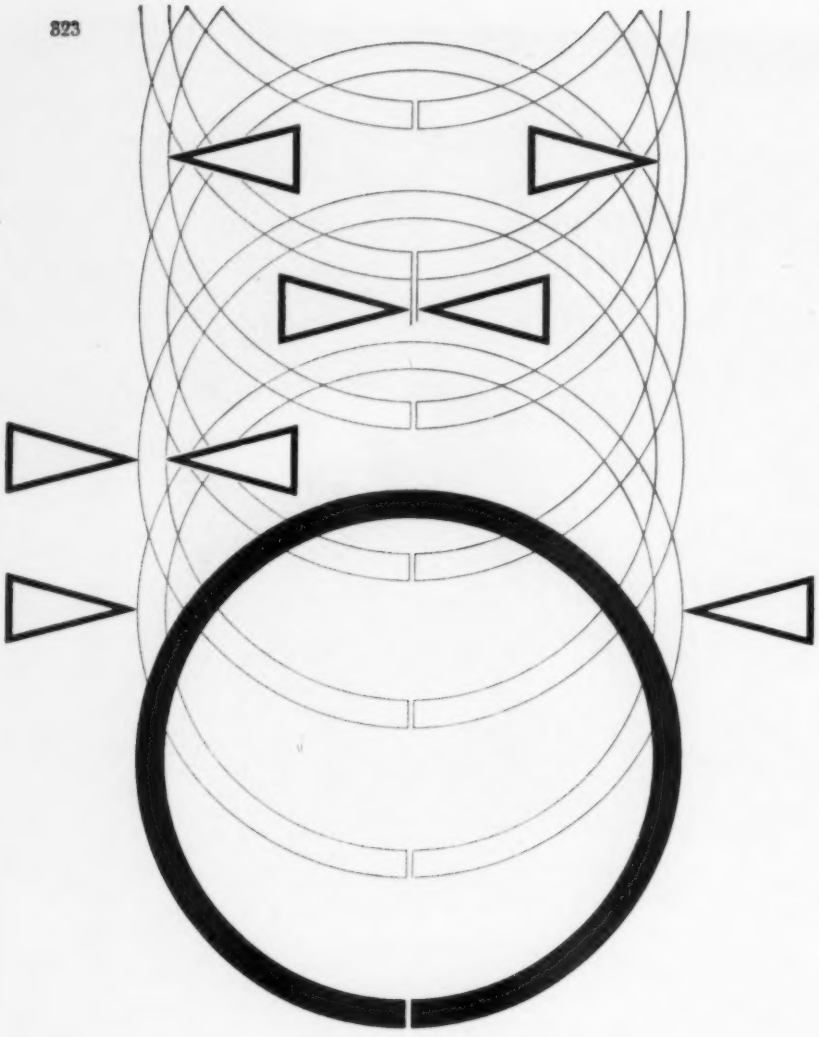

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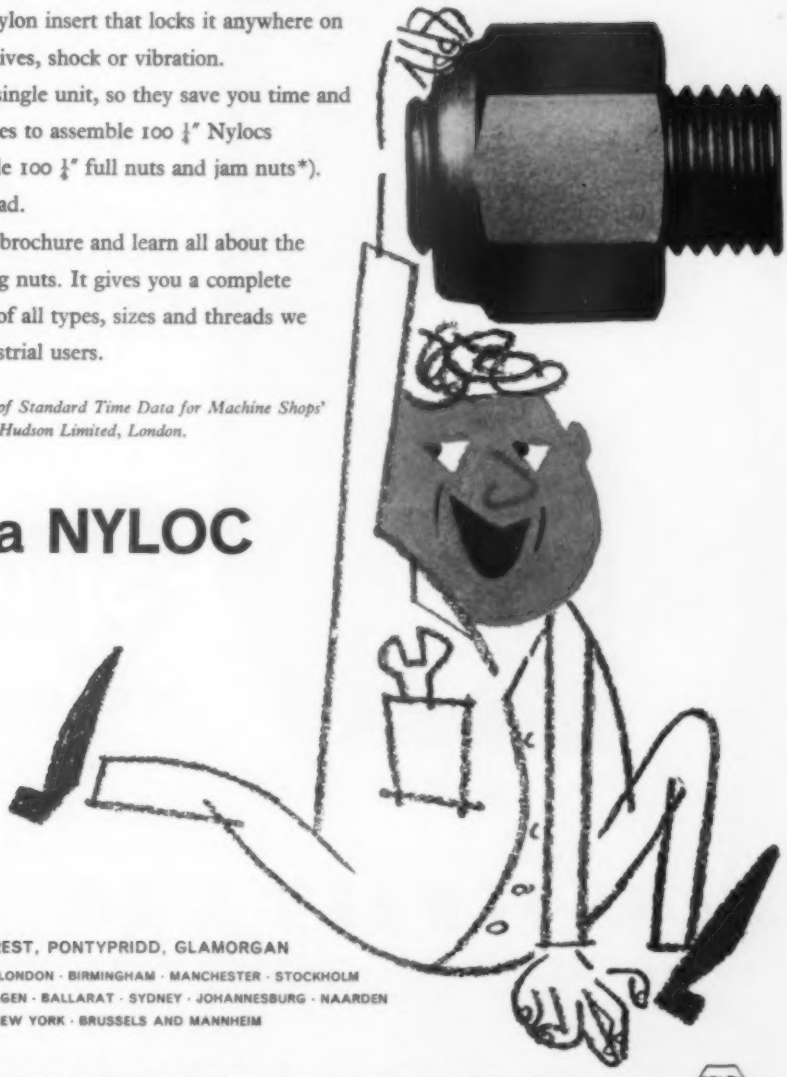
** These times are based on 'The Handbook of Standard Time Data for Machine Shops' by Haddon & Genger, published by Thames & Hudson Limited, London.*



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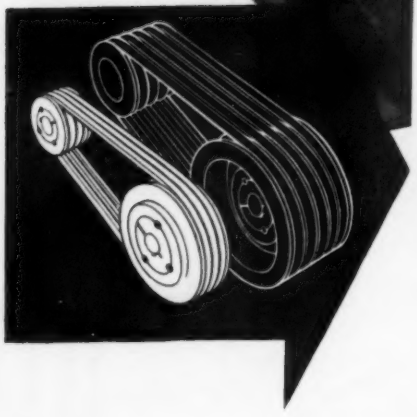

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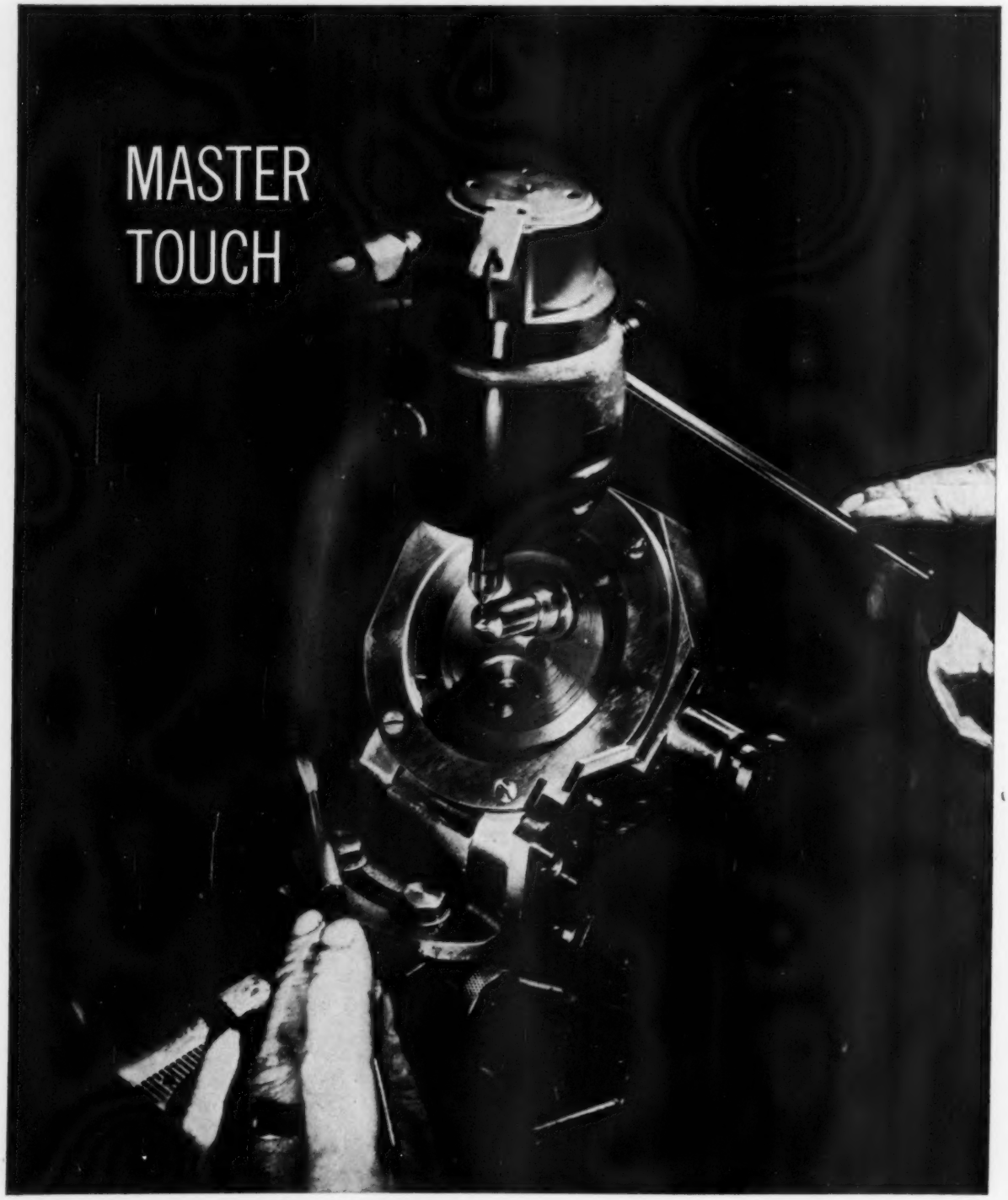

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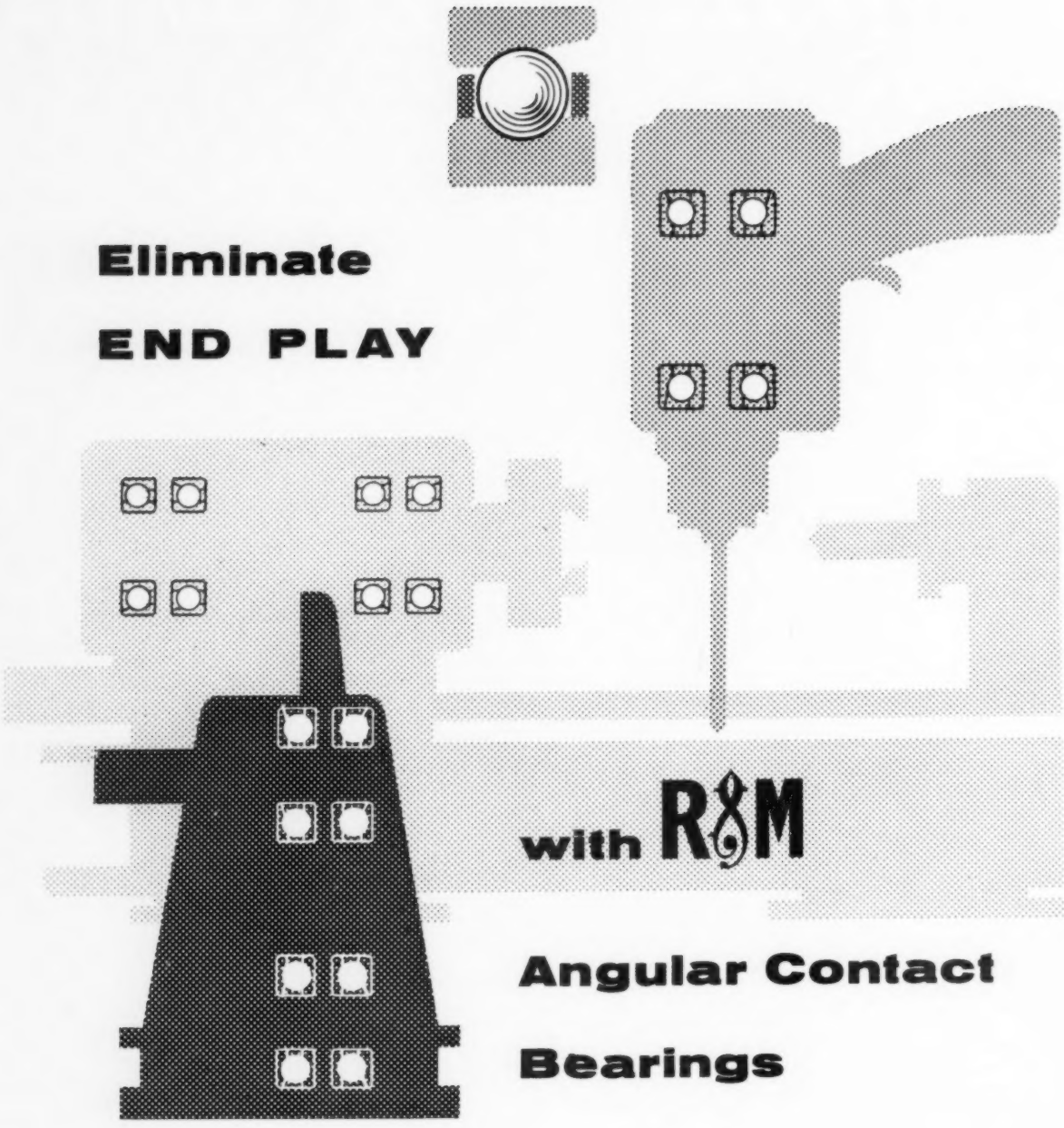

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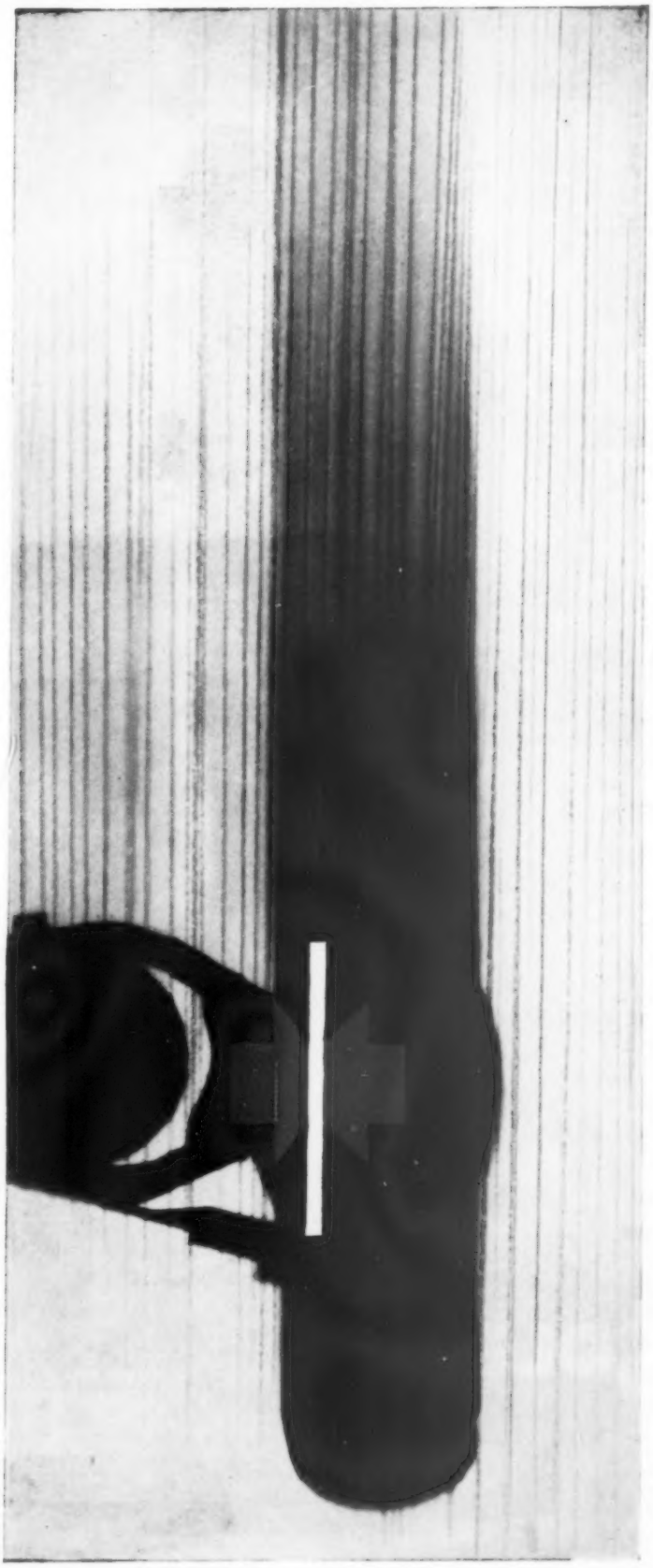

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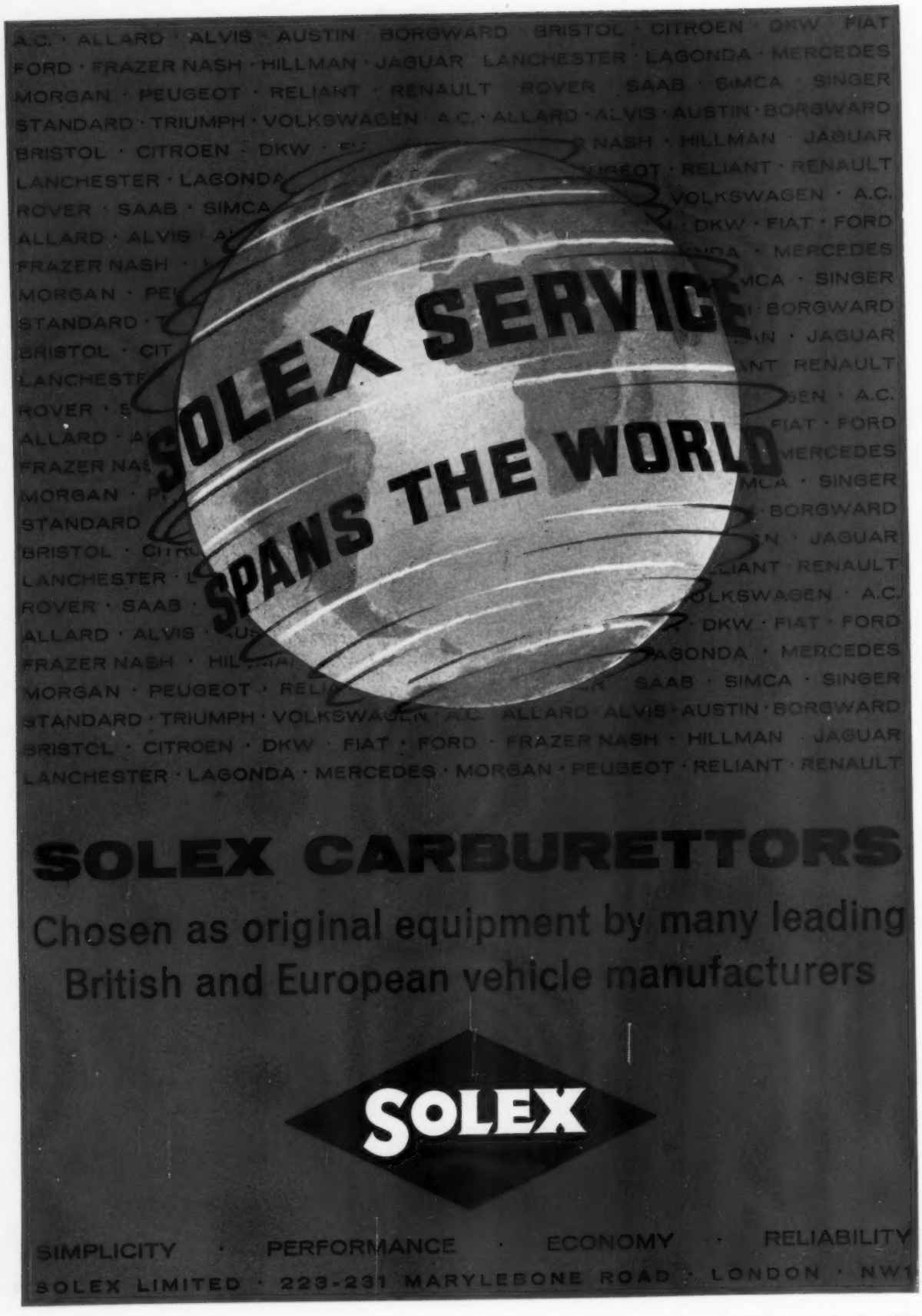
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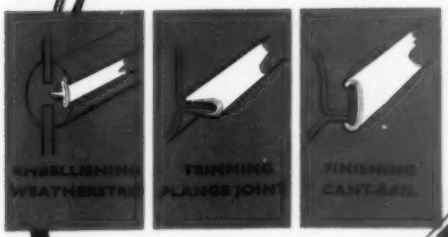

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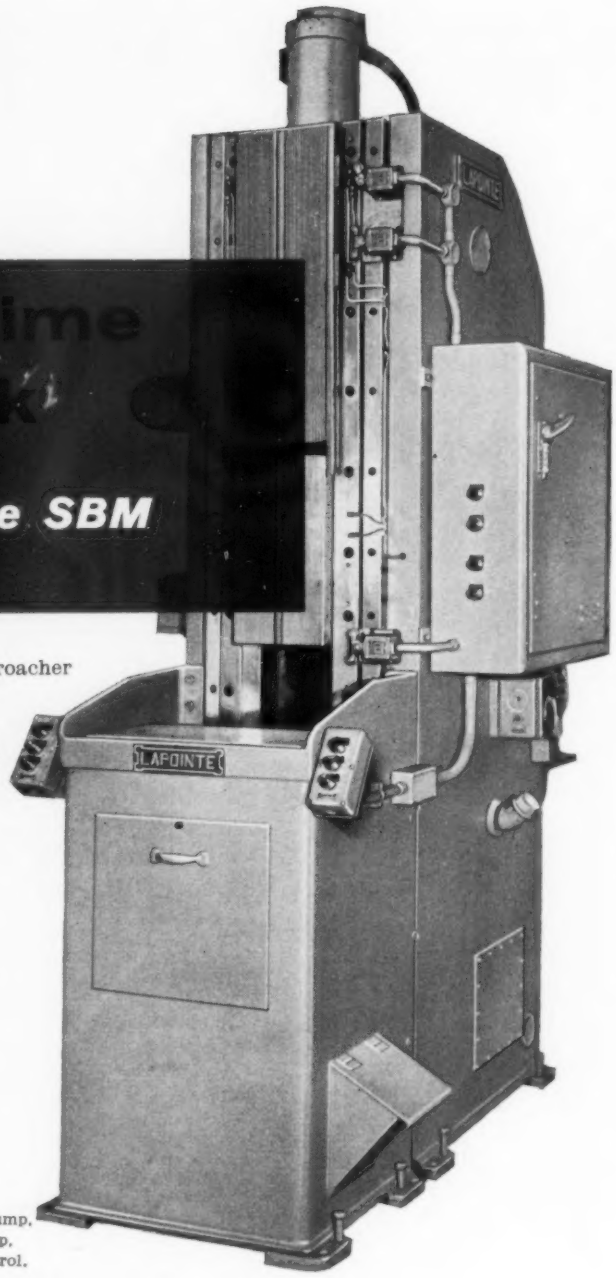

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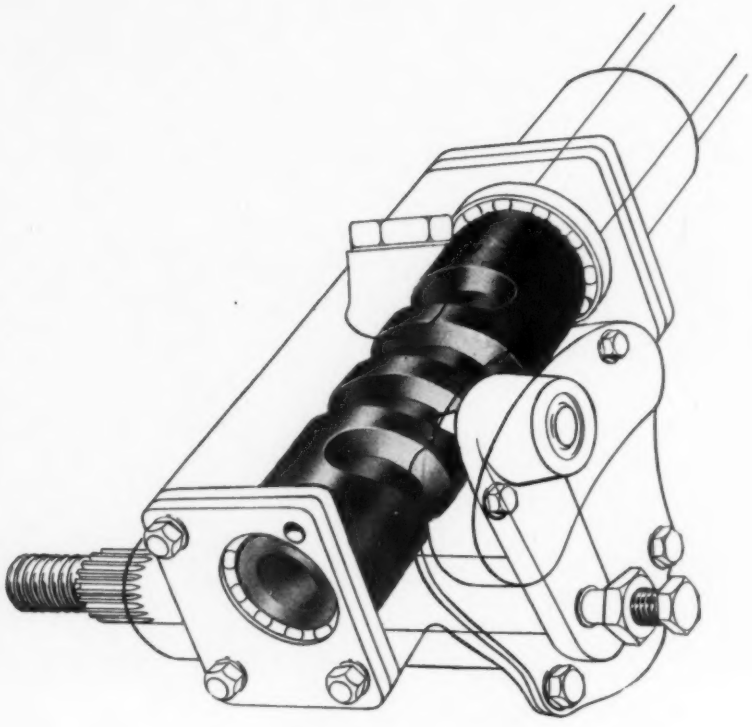
QUALITY STEELS FOR AUTOMOBILE ENGINEERING



1825 EXPERIENTIA DOCET 1961

special freecutting
casehardening
quality bars

THE PARK GATE IRON & STEEL COMPANY LIMITED ROTHERHAM
A GKN Company TEL: ROTHERHAM 2141 (15 lines) GRAMS: YORKSHIRE, PARKGATE, YORKS TELEX 54141

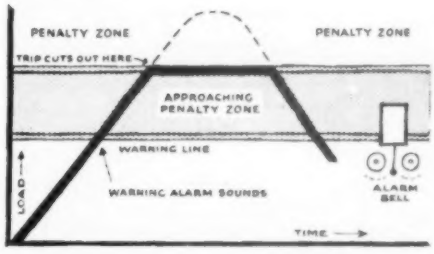
Load Factor Improvement

Most industrial electricity tariffs consist of a fixed charge based on the maximum demand for electricity by the works and a running charge for each unit (kWh) of electricity used. Broadly speaking, the fixed charge covers the capital cost of generating, transmitting and distributing equipment for the particular demand and the running charge covers the cost of generating the units.

Thus, if the factory maximum demand is reduced for the same level of consumption or is held constant for an increased consumption, the cost per unit will be reduced. This is termed improving the 'load factor': load factor being defined as the ratio of the number of units supplied during a given period to the number of units that would have been supplied had the maximum demand been maintained throughout the period; it is usually expressed as a percentage. Some ways in which load factor can be improved are:

SUPERVISION AND CONTROL OF MAXIMUM DEMAND

A maximum-demand alarm gives a warning when the maximum demand is about to be exceeded. One of the simplest devices has two warning contacts, but, as a useful addition, an auxiliary relay can be supplied so that non-essential load can be tripped automatically.



The Load Limiter, an automatic device, meets the requirements of medium and large consumers who wish not only to control their system loading to some target maximum but also to improve the load factor in order to increase the overall economy of the plant.

EXAMPLES OF REDUCTION IN MAXIMUM DEMAND

Broadly speaking, loads which contain some storage element can be transferred from on-peak to off-peak times. Examples are: charging electric batteries used in industrial trucks and road vehicles; pumping loads in drainage schemes; water pumping in quarries, gravel pits and other open-air workings; large cold-storage warehouses; ice-making factories in which cost of power is a sufficiently large item of the operating expense to make a reduced charge acceptable.

Many processes at times of peak demand can, under controlled conditions, tolerate a temporary reduction, or even cessation, of supply without any serious effect on the product. With electro-chemical processes such as in the manufacture of hydrogen peroxide no difficulty arises from periodic interruptions at short or even no notice.

In a plastics factory the management arranged for dies to be switched on by time switches one after another early Monday morning so at the beginning of work all dies had reached their operating temperatures. Previously they were switched on more or less simultaneously by hand when work started, resulting in an abnormally high demand.

In a certain chemical works compressed air is used for blowing out containers for plastic material. The nature of this operation is such that the consumption of air is spasmodic and irregular. The demand-recording meter in this works showed that the 18-kilowatt motor driving the air compressor was frequently cutting in on top of the factory load, thus incurring a higher maximum-demand charge. In this case all that was necessary was to ensure that the air receiver only required charging at night-time or at other off-peak times. It was found that the existing receiver had such a small capacity that the pump had to operate to recharge it almost every time the blowing operation took place. This small receiver was therefore replaced by a receiver of large enough capacity to maintain the blowing requirements over the peak periods without further charging.

EXAMPLES OF INCREASED CONSUMPTION FOR THE SAME MAXIMUM DEMAND

Often when the requirements of a factory are studied it is found that there are additional processes for which electro-heat can economically be employed because furnaces or other equipment can be arranged to be switched off or to take a reduced load during periods of peak demand. A sheet metal foundry with an early morning peak found that it would be an economical proposition to use an infra-red oven switched on after the peak period had passed because such ovens are ready for use in a few minutes. The possibilities of electric space heating in this respect are dealt with in Data Sheets 18 and 19.

For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books are available on electricity and productivity (8/6 each, or 9/- post free) — 'Higher Industrial Production with Electricity' is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity. Ask for a catalogue.

7926

CUT HERE

THE AUTOMOTIVE DIVISION OF THE

HARDY SPICER LIMITED—STAND 359

Progressive development has more than met the technical demands of the Motor Industry. Whatever the future requirements of engineers and designers may be, the intensive research carried out by Hardy Spicer ensures that their propeller shafts, universal joints and constant velocity joints will be capable of meeting them.

LAYCOCK ENGINEERING LIMITED—STAND 358

Manufacturers of the famous Laycock de Normanville overdrive. New products include the Laycock Clutch (Haussermann system), a design centred around a diaphragm spring and offering important advantages. Other Laycock exhibits include flexible couplings and propeller shafts, centre bearings and universal steering joints.

SALISBURY TRANSMISSION LIMITED—STAND 357

Particularly featured is the Powr Lok differential, a limited slip design which provides maximum traction automatically under all road and weather conditions. Also exhibited are complete Salisbury axles, which are still widely adopted by leading automobile manufacturers, and Salisbury axle units which are being supplied for cars embodying independent suspension systems.

FORGINGS & PRESSWORK LIMITED—STAND 356

Cold extrusions in steel manufactured by this Company make possible the production of generallysymmetrical parts to close tolerances. Many machining operations are avoided for such parts as shock absorber cylinders, dynamo carcases, universaljoint flanges and gear box components. Forgings and Pressings used throughout the motor industry will also be displayed.

BIRFIELD GROUP

MOTOR SHOW 1961
GROUP STAND
355-359
FIRST FLOOR · AVENUE 'L'

BOUND BROOK BEARINGS LTD
STAND 310
FIRST FLOOR · AVENUE 'F'

BOUND BROOK BEARINGS LIMITED—STAND 310

Self-lubricated bearings for various linkage and electrical unit applications have been augmented by Polyslip bearings. These are P.T.F.E. impregnated in sintered bronze with lead additive. No lubrication is required, even in dusty or wet locations. Lichfield P.T.F.E. filter elements have also been developed in addition to the sintered metal types which are already in widespread use.

Other Birfield Companies exhibiting are:—
THE PHOSPHOR BRONZE CO. LTD.—STAND 355
SHOTTON BROS. LTD.—STAND 355
LAYCOCK ENGINEERING LTD.—STAND 473
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THE AUTOMOTIVE DIVISION OF THE **Birfield Group**

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Forgings and Presswork Ltd.
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Kent Alloys Ltd.
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BIRFIELD INDUSTRIES LIMITED (Automotive Division)
CHESTER ROAD · ERDINGTON · BIRMINGHAM 24

LET'S GET IN TOUCH WITH TECALEMIT

... they're sending out some wonderful things from Plymouth

Tecalemit research and development are on the simmer all the time, finding new ways to solve car manufacturers' trickiest problems. Some of Tecalemit's brainwaves—all proved in practice and making a name in industry—are ...

TEC-ELEMENTS Biggest ever filtration area, most effective filtration, longest working life . . . best engine protection. Recommended and fitted as original equipment by the vast majority of British car manufacturers.

TECALEMIT RIBBON FILTER ELEMENTS Finest filtration at lowest cost of air, water, petrol, diesel and fuel oils, lubrication, hydraulic — just about every fluid you'd like to mention.

TECALEMIT NYLON TUBING Outperforms metal, other plastics and rubber tubing for strength, flexibility, vibration-resistance, chemical and corrosion resistance. This is precision high pressure tubing and it is making a big difference in hydraulic brake hose techniques. It is also used as oil or fuel lines by Aston-Martin, Austin, Ford, Jaguar and other leading manufacturers.

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THE AUTHORITY ON LUBRICATION AND FILTRATION

TT31

Car parts take a beating in today's traffic

Modern cars need modern materials—materials like Tufnol, made in numerous brands with pre-determined properties, each formulated to satisfy particular requirements.

Tufnol—a laminated plastics material—has a wide range of properties which make it eminently suitable for automobile components. Light yet strong and hardwearing, it is not damaged by petrol, oil, dilute acids and climatic conditions; it is an electrical and thermal insulator, is dimensionally stable and machines easily using ordinary tools. Available in sheets, tubes, rods, bars, angles, channels and mouldings, it can be stored indefinitely, and resists attack from insects, rodents and fungi.

The Tufnol Zodiac is your guide to the twelve most important brands of this remarkable material. Get to know them and you will find they will save your time and money. We shall be glad to send you further information, or to give you technical advice.

TUFNOL

(Reg. Trade Mark)

TUFNOL LIMITED · PERRY BARR · BIRMINGHAM 22B

435

Competitors are infuriating people. Their machines are always bigger and more modern than yours. Their production line is faster and more streamlined. No wonder they catch more business and make more money. Of course if *you* had more machines *you* would make more money too. Alternatively, if you had more money you could buy more machines. A vicious circle: but UDT can break it. UDT can lend you the money to buy the machines, and you can repay us with the extra money they bring in. Let's hear from you and we'll see what we can do.

UDT HELPS INDUSTRY TO HELP ITSELF

UNITED DOMINIONS TRUST (COMMERCIAL) LIMITED · 51 EASTCHEAP · LONDON EC3

DO YOU . . .

It takes at least thirty people—thirty pairs of skilled hands—to make one DORMER Drill. Every operation is performed by experienced operators with the most up-to-date machinery. Careful heat-treatment and inspection are equally essential in maintaining the consistently high standard of DORMER Tools.

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PERFORMANCE

With correct use, a DORMER Drill of 1" diameter, in its lifetime on general purpose work, will remove 2,800 times its own weight in material (over 1¾ tons), and drill a total length of hole five hundred yards long!

DORMER

TWIST DRILLS

THE FINEST BY ANY STANDARD

Brilliant Design

but that's not all...

In the manufacture of propeller shafts and universal joints, Hardy Spicer are without equal. Through long association with every leading British vehicle manufacturer, Hardy Spicer have acquired that kind of technical 'know-how' which can only result from many years' experience. Skill and ingenuity are not enough. The vital ingredient of time is necessary before propeller shafts and universal joints can be mass-produced to give smooth, dependable transmission.

HARDY SPICER

PROPELLER SHAFTS

HARDY SPICER LIMITED

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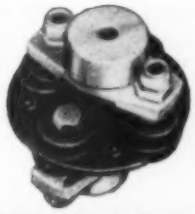
AUTOMOTIVE DIVISION OF B

FLEXIBLE COUPLINGS

STAND 306
International
Motor Show

Whenever a power transmission system is susceptible to angular or linear misalignment or significant vibration, there is a Silentbloc Flexible Coupling to suit the case. The wide range and variety available from stock can be augmented by 'specials' to meet really unusual demands. Our advisory service is freely at your disposal without obligation.



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FOR ROAD AND RAIL TRACTION INDUSTRY • MARINE APPLICATIONS INSTRUMENTATION • ELECTRONICS

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Andre Rubber Co. Ltd., is another Silentbloc Company.

Silentbloc products are also manufactured by Silentbloc (Australia) Pty. Ltd., Melbourne

Broadway 5/114

Bonding a sealing strip in the weather channel round the engine of an Austin 7 with adhesive based on Du Pont neoprene.

HOW AN ADHESIVE BASED ON DU PONT NEOPRENE SOLVED AUSTIN'S BONDING PROBLEMS

At the Austin Motor Company's works at Longbridge, Birmingham, a large number of the assembly jobs involve bonding. Roof-linings, dashboard fittings and some weather-stripping require a secure and lasting bond.

■ Up until 1958 many different types of adhesives were in use, rendering both the assembly work and the stock position unnecessarily complex. These were two of the reasons why the British Motor Corporation seized the opportunity to change to a neoprene-based adhesive that would do all the jobs previously done by a large variety of rubbers and cements.

■ Du Pont neoprene is chemically stable and will dissolve in solvents and solvent mixtures to give adhesive solutions of varying viscosities and drying rates. It can be compounded to form the ideal adhesive for an almost limitless range of materials. For leathercloth in particular a neoprene-based adhesive is recommended. It will not weaken with age or degenerate under those extreme conditions of weather to which exported vehicles are often subject. Bonds effected by solvent adhesives based on Du Pont neoprene are also highly resistant to degradation by oils, chemicals and water, as well as heat, sunlight and ozone.

■ To find out how adhesives based on Du Pont neoprene can solve *your* bonding problems, send the coupon below for further information and list of suppliers to the Du Pont Company (United Kingdom) Ltd., 76 Jermyn Street, London, S.W.1.

NEOPRENE

DU PONT

REG. U. S. PAT. OFF.
Established 1802

BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY

Du Pont Company (United Kingdom) Ltd., 76 Jermyn Street, London, S.W.1, England. *Please send me literature and a list of suppliers of adhesives made from Du Pont neoprene.*

NAME.....

POSITION.....

COMPANY.....

ADDRESS.....

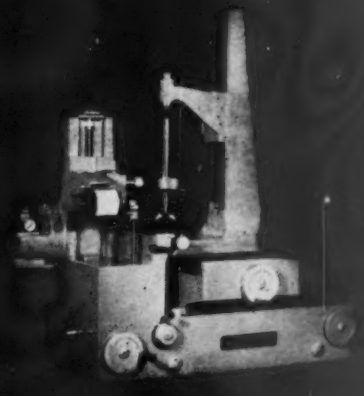
.....

AUTO ENGINEER 10/61

David Brown MACHINES

. . . with
David Brown CUTTERS

. . . with David Brown
MEASURING EQUIPMENT



. . . for best results!

Co-ordinated equipment for maximum efficiency on gear shaving

All your gear shaving and testing equipment from one organisation. The perfect relationship in design and performance, giving peak efficiency at every stage. That's the ideal for best results.
And that's what you get when you buy David Brown gear shaving and measuring equipment.
David Brown are ready to prove it !

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Telephone: TRAFFORD PARK 4741

TOOL DIVISION, PARK WORKS,
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Telephone: HUDDERSFIELD 3500

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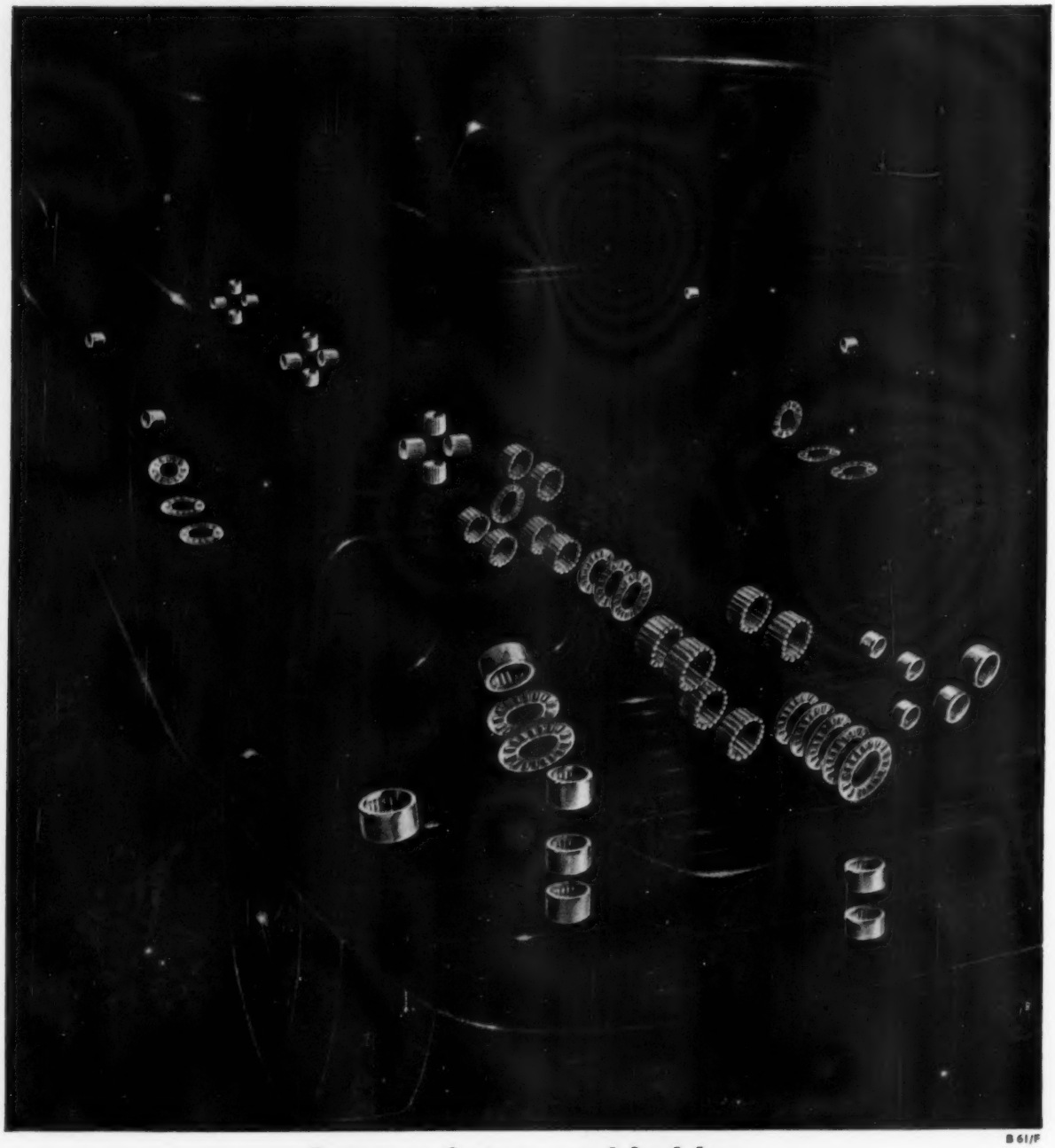


B 61/F

Is your future guided by Torrington automotive bearings?

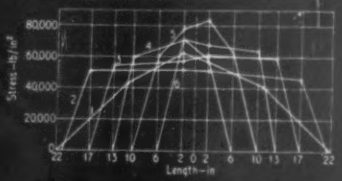
Emphatically, yes. These bearings, backed by Torrington's creative engineering, will be vital to your future progress. Tomorrow's designs will profit from the advantages offered by these unique antifriction bearings. But for Torrington Needle Bearings, advances such as automatic transmissions, power steering and windows, and other power-operated equipment might still be in their infancy. Torrington offers creative co-operation to the research and engineering people who make automotive improvement possible, providing a partnership in progress to ensure future advances in the design, material and performance of antifriction assemblies. For PROGRESS THROUGH PRECISION — IN BEARING DESIGN AND PERFORMANCE call in our engineers, and/or send for full descriptive literature.

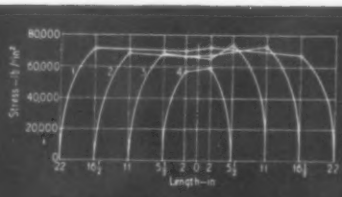
THE TORRINGTON COMPANY LTD

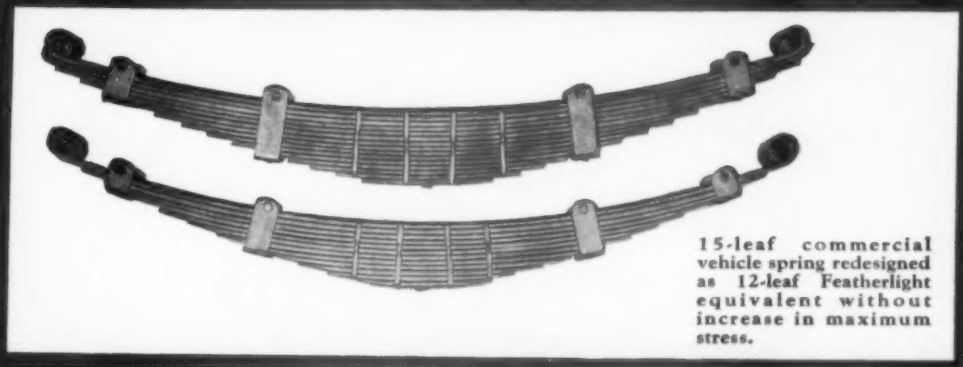
Bearings Division: Torrington Avenue, Coventry. London and Export Office: 7-10 Eldon Street, E.C.2. Glasgow Office: 50 Wellington Street, C.2

HOW TO SAVE SPRING WEIGHT WITHOUT INCREASING STRESS

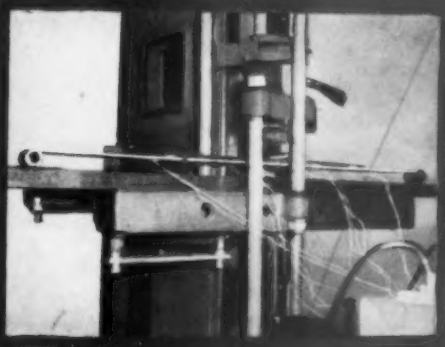
Production spring with 6 leaves redesigned as a 4-leaf Ideal spring.







15-leaf commercial vehicle spring redesigned as 12-leaf Featherlight equivalent without increase in maximum stress.

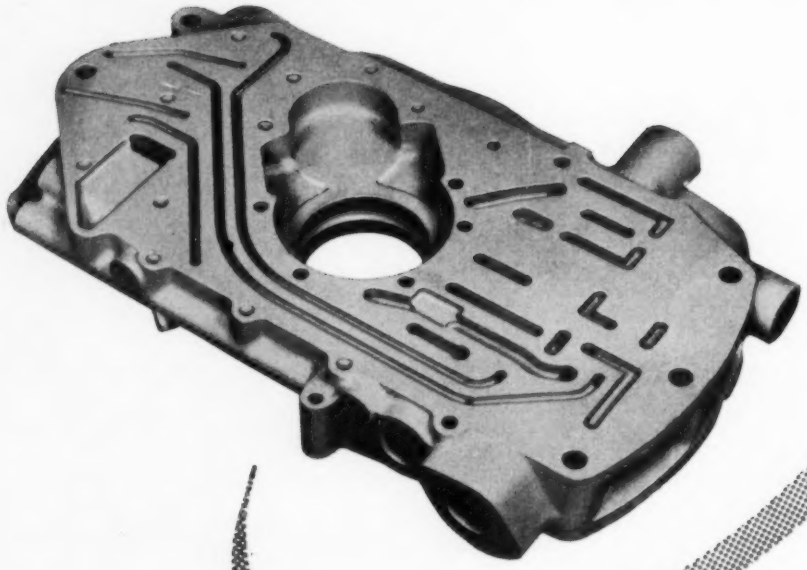


TWS
featherlight
IDEAL SPRING
(PATENTS PENDING)

TOLEDO WOODHEAD SPRINGS LIMITED
AYCLIFFE NR. DARLINGTON and SHEFFIELD 3

Cast with Precision

- Aluminium and magnesium alloy castings by sand, die, shell and plaster mould methods.
- Engine blocks and cylinder heads in high duty iron.
- Castings of the highest quality in the desired quantities at the right time.
- The greatest technical experience augmented by quality control of production.



Automatic Transmission Part in Aluminium produced by Shell Moulding. The slots are in the 'as cast' state and are not machined. By courtesy of Hobbs Transmission Limited

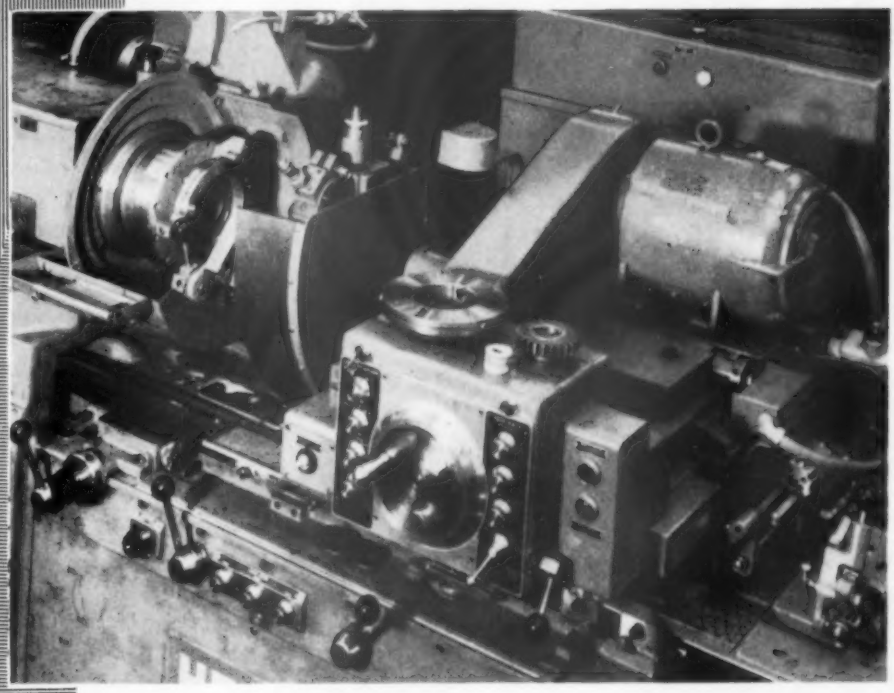
STERLING METALS LTD

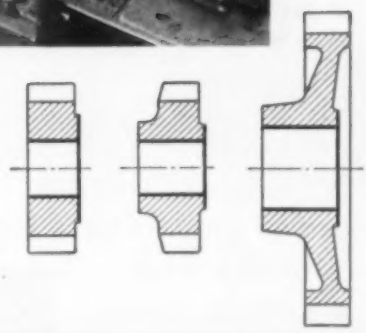
PHONE NUNEATON 4221

—— cutting costs on a

HEALD INTERNAL GRINDER

precision grinding four different gears in one set-up on one machine





These gears are of three different contours as shown. Finish in the bore is 15 micro-inch and on the face 20-25 micro-inch. Bore and face are square to .0005". Stock removal .012".

Gear is located in an adapter and held in a pneumatic diaphragm chuck. Bore is ground with table reciprocation and standard Sizematic cycle. When finished to size wheelhead is indexed forward and face is plunge ground with the facing attachment.

it pays to install HEALD *machines*

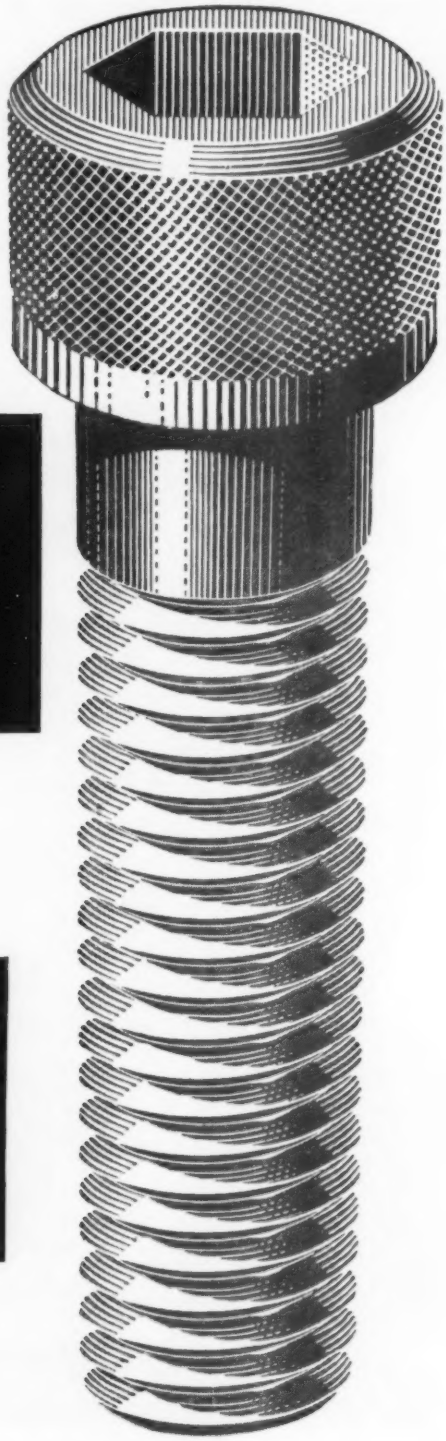
The Models 171 and 271 Grinders are now British-built with either Sizematic or Gagematic sizing. Both models are completely automatic except loading and unloading. Model 271 is also offered as a Plain machine, which is semi-automatic.

Our specialists are available to advise on their application and we will quote for machines, completely tooled to suit customers' components.

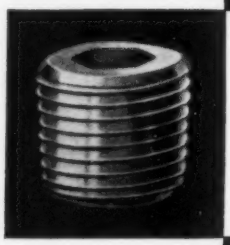
ALFRED HERBERT LTD., COVENTRY *Factored Division, Red Lane Works.*

AD. 501

NPK SOCKET SCREWS



are made to higher standards
of dimensional accuracy,
strength and uniformity
than any other
comparable product.



Cap,
Set,
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or Shoulder.
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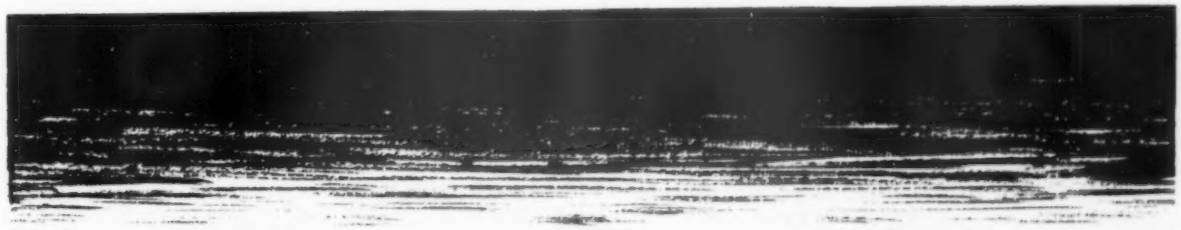
B.S.F. or Whitworth
UNC or UNF.

NPK Socket Screws
are as good as they look.
We only wish
we could make
them look
as good as they
really are.

NPK WEDGLOK self-locking socket screws
and **NPK HEXAGON WRENCHES**
are also available.

GKN

Guest Keen & Nettlefolds (Midlands) Ltd., Screw Division: Box 24, Heath Street, Birmingham 18. Tel: Smethwick 1441. Telex: 33-239
S/S/2312



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FOR

ELECTROPLATING
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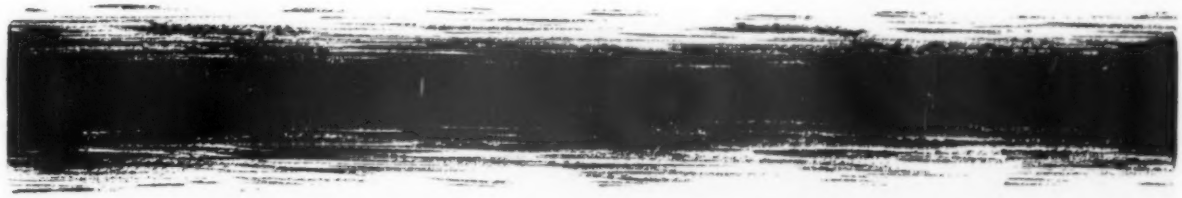
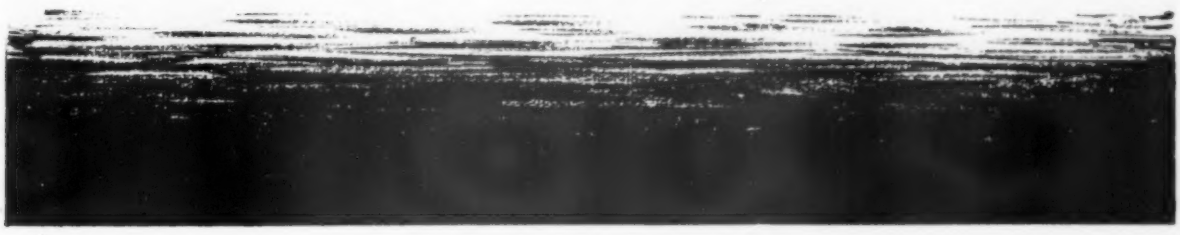
SPECIALISTS IN PLATING TO SPECIFICATION



IONIC PLATING CO. LTD.

GROVE STREET, BIRMINGHAM, 18 Telephone: Smethwick 2951 (8 lines)

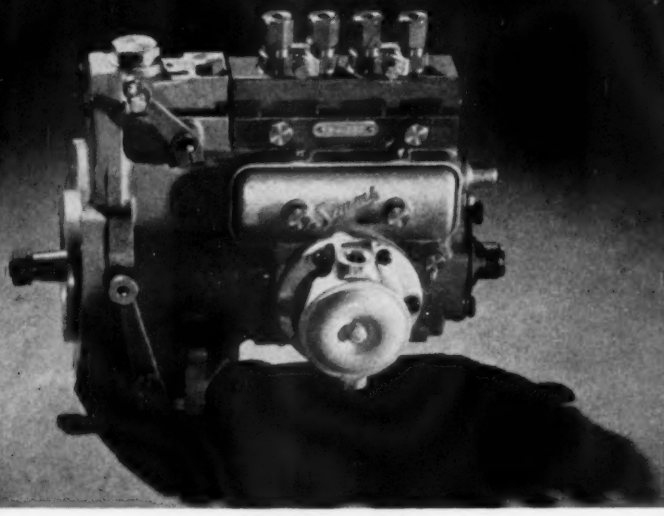
AIRLITE—IONIC LIMITED, EDINBURGH



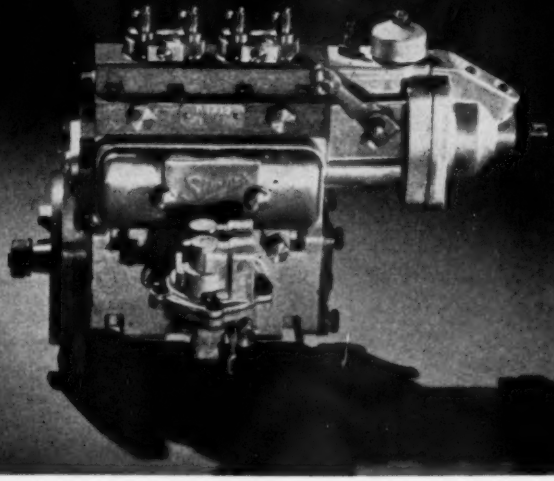
Simms

Simms are the largest manufacturers of British

MINIMEC (the mechanically-governed Minipump)

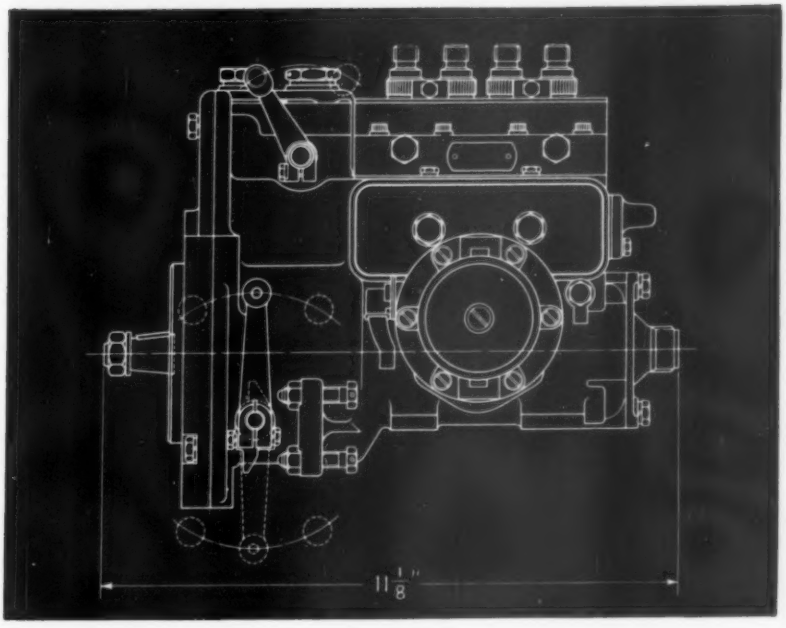


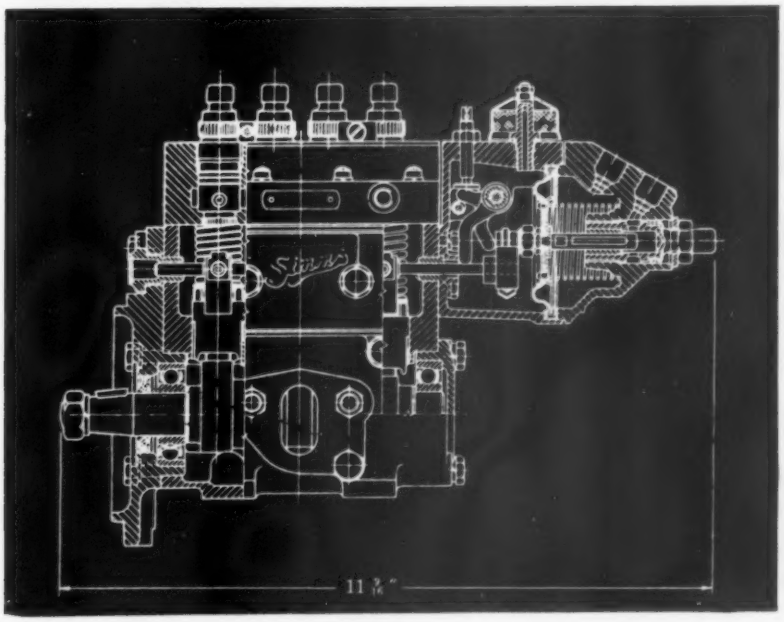
MINIVAC (the vacuum governed Minipump)



Simms

designed and built fuel injection equipment





MINIMEC

This latest addition to the Minipump range is identical, except for its integral governor, with the Minivac fuel-injection pump, and suitable for engines up to 1.5 litres per cylinder. The centrifugal governor will maintain any set speed between idling and maximum. The excess fuel device (for starting) is only operable with the engine stopped and consequently is tamperproof. The Minimec gives closer speed control and better fuel economy than any pump of comparable size and weight made anywhere in the world.

Some points in the design

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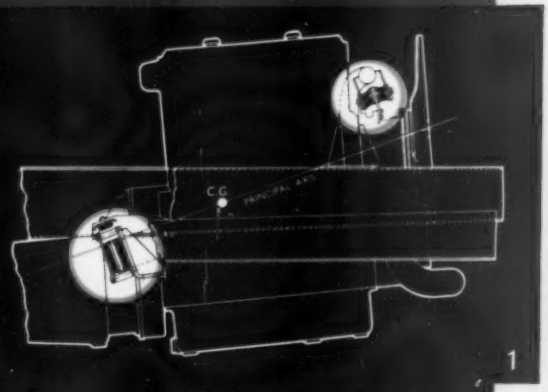
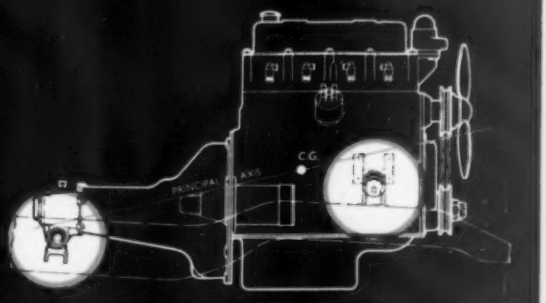


1

If practical considerations could be ignored there would be no problem in providing the ideal suspension for every motor vehicle engine. Mountings would be disposed symmetrically about all three principal axes of inertia and fitted on the longitudinal axis on the lines of "Floating Power" — the suspension technique developed by Metalastik in this country Such an arrangement is not often convenient and the most successful engine suspension is generally a compromise, simulating as closely as possible the characteristics of the ideal but respecting the claims of easy installation and other technical and economic factors so often at variance with theoretical perfection.

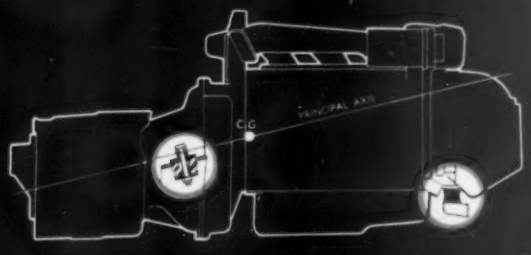
Examples of Metalastik suspension in Figs. 1, 2 and 3 illustrate how a combination of sound theory, appreciation of the practical and choice from an unequalled range of mounting units, bring maximum smoothness to different types of engine.



2

The suspension in Fig. 1 with the high front mounting resembles more closely the original "Floating Power" conception than is now usual. Secondary out-of-balance forces and a flexible chassis necessitate mountings with a large degree of vertical and rotational flexibility, hence the use of shear mountings at all three points. Pre-compression of the rear mountings permits higher stressing without loss of fatigue life.

Fig. 2 shows a typical suspension for a 4-cylinder motor car engine. Interleaved sandwich mountings are below the principal axis but 'focused' in 'V' formation to give the same rotational characteristics as mountings fitted higher but with their compression axes in a vertical plane. The Metaxentric bush at the rear controls fore-and-aft movement and has a higher deflection than a concentric type.



3

For the 3-cylinder opposed piston engine (Fig. 3) in which balancing has virtually eliminated the primary, vertical out-of-balance couple, slotted Metacones and the way in which they are fitted, provide high rotational flexibility about the vertical axis essential for insulation of vibration due to a horizontal out-of-balance couple.

Diagrams reproduced by courtesy of the Institution of Mechanical Engineers from the paper "The Suspension of Internal Combustion Engines in Vehicles", by M. Horovitz, B.Sc., (Eng.), A.M.I.Mech.E.

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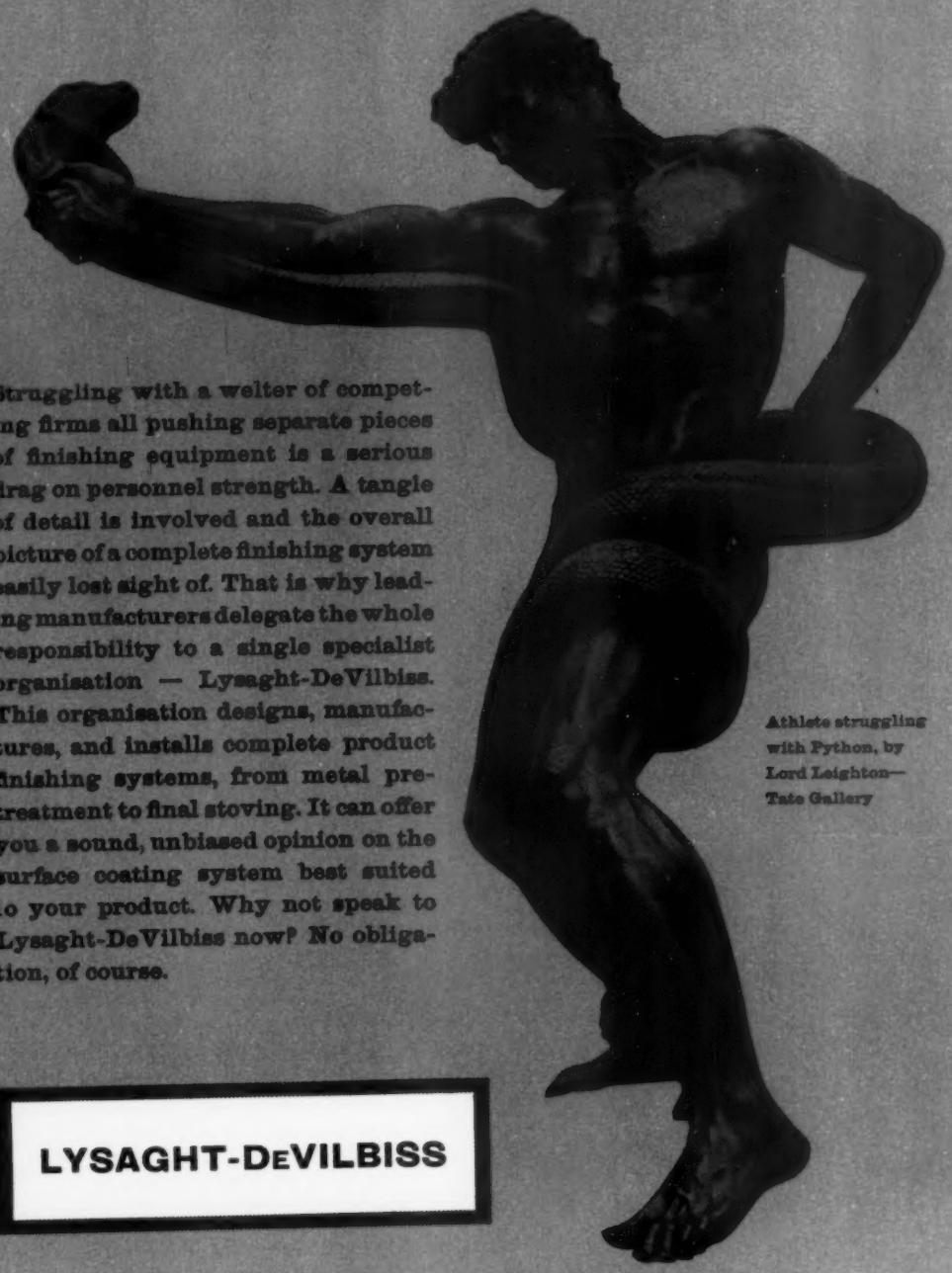

Athlete struggling with Python, by Lord Leighton—Tate Gallery

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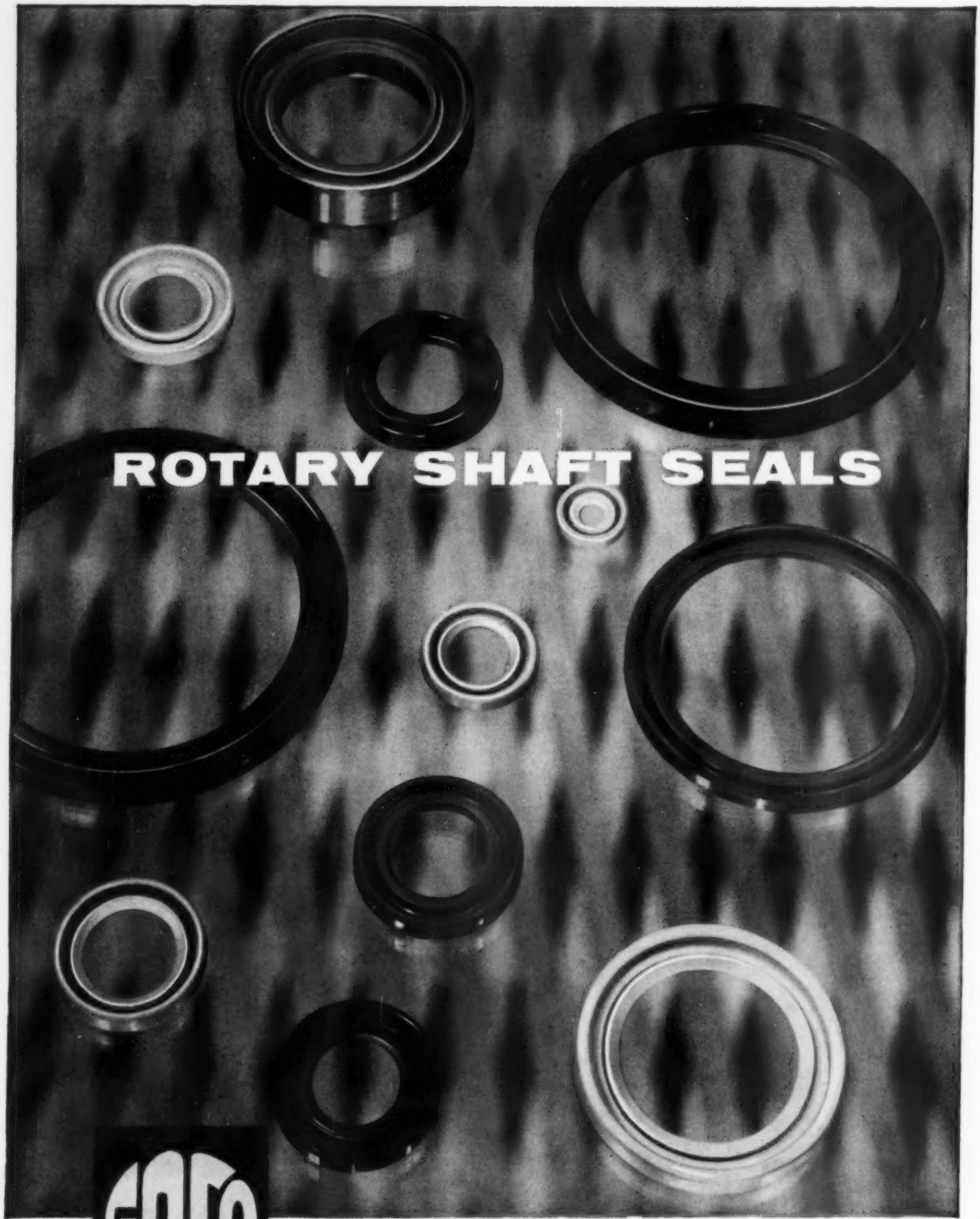

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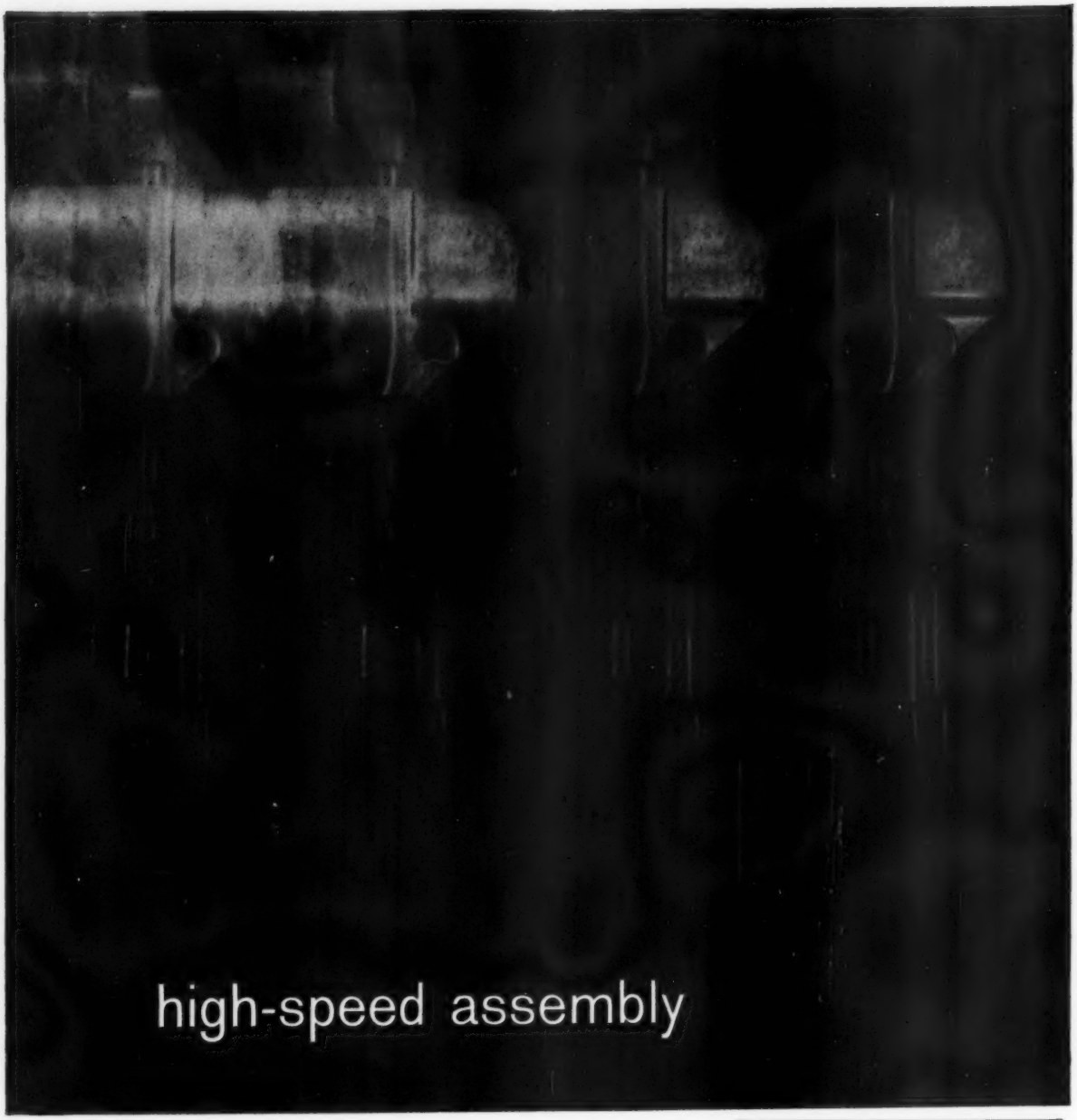

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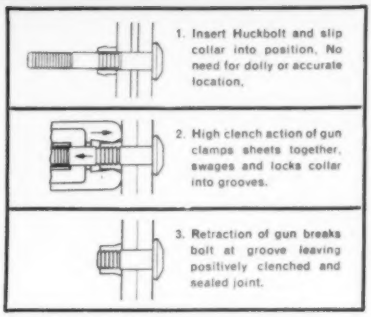
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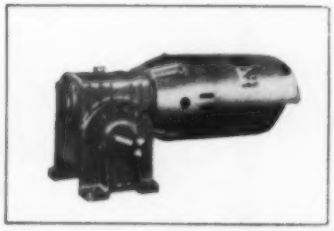

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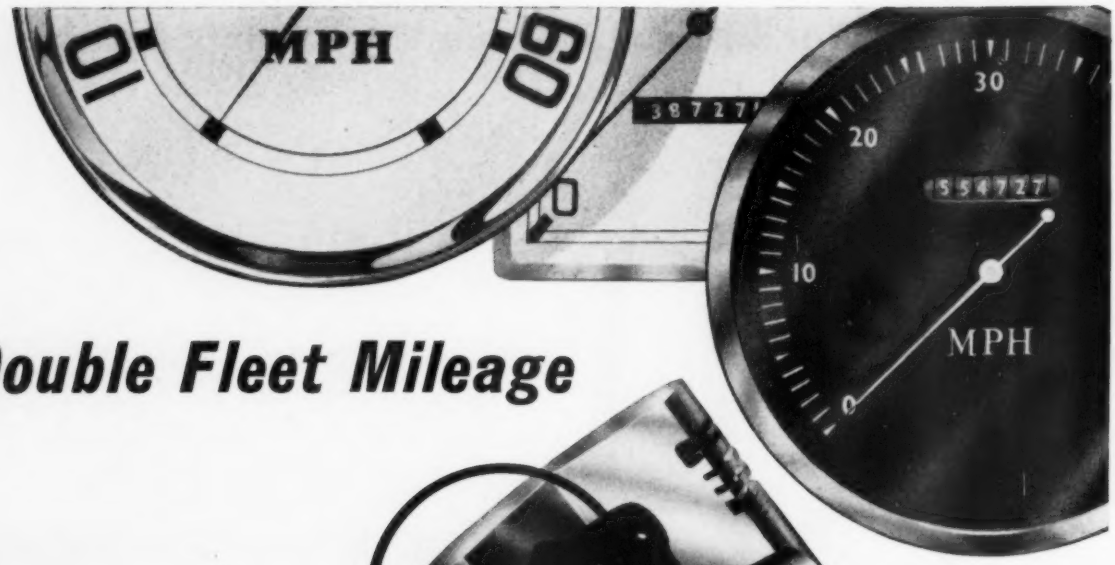

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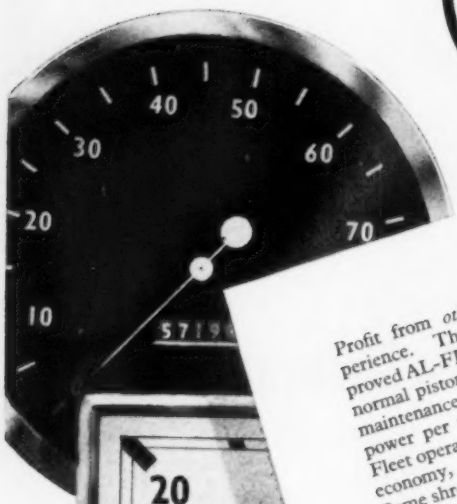

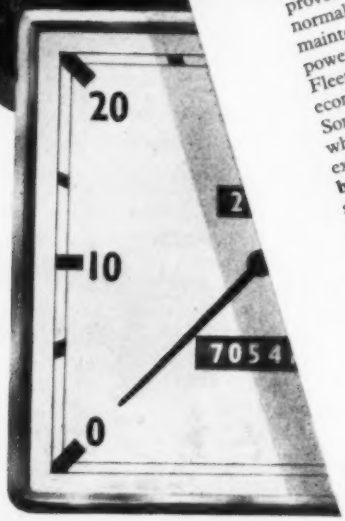

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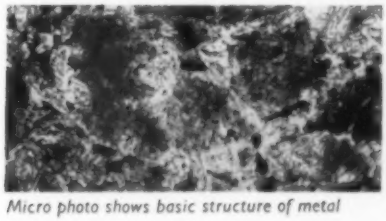
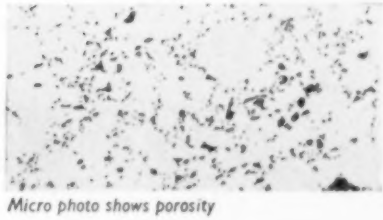


Micro photo shows basic structure of metal



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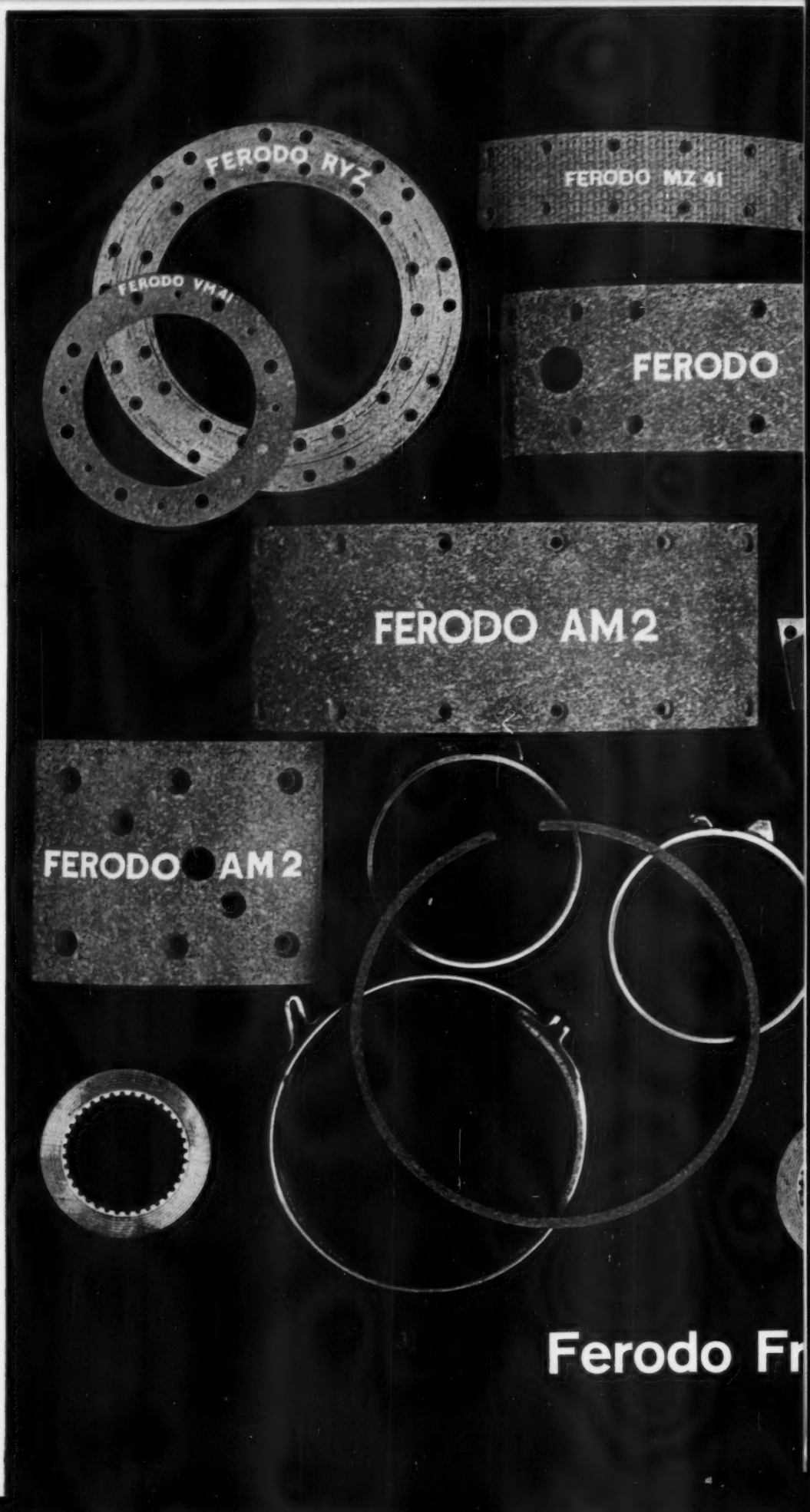

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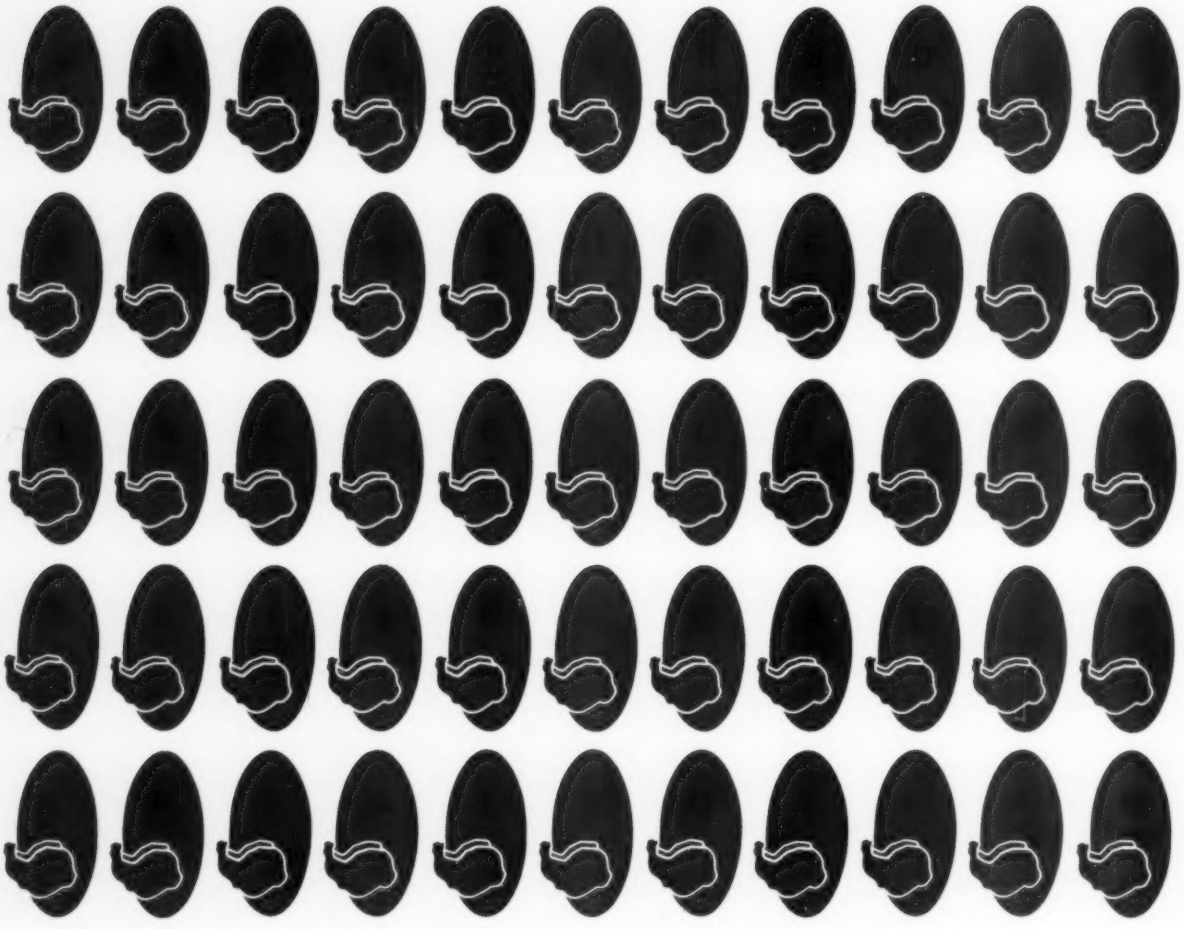

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OCTOBER 1961 Volume 51 Number 10

AUTOMOBILE ENGINEER

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AUTOMOBILE ENGINEER

DESIGN · MATERIALS · PRODUCTION METHODS · WORKS METHODS

Learning from Motor Shows

A MATTER of days after this issue of *Automobile Engineer* is published, many of our readers will be attending the London Show—but with what object? All too frequently, one gets the impression that it is to spot the defects in other manufacturers' vehicles and thus to return home with a comforting, but unjustified, feeling of complacency. Obviously, the greatest benefit is gained by those who visit the show with the intention of concentrating on discovering the good features of the exhibits, while at the same time learning from the pitfalls into which other designers have fallen.

Certainly, no original and progressively minded designer will go with the limited objective of copying other people's work. Rather will the emphasis be on studying the advances already made, and concentrating efforts on further improvement. A widely held view is that estimates of trends, if based on observation of current models, are inevitably out of date. But the directions in which some aspects of design will move in the next few years can in fact be predicted with surprising accuracy from a study of the latest exhibits: in some instances it may be that an innovation introduced by a firm having a very large output is bound to have a considerable impact, and in others that a study of the work of manufacturers renowned as leaders of fashion, or in specialist technical spheres, will be rewarding.

Although many foreign vehicles are exhibited at Earls Court, trends in other markets are more easily discerned at shows in or near the areas in which those markets are situated. This is partly because the products of local manufacturers are, of course, always given greatest prominence in their own national shows, and partly because those exhibited outside their countries of origin may have been adapted to that particular export market. Frequently, too, a trend emerges locally because an innovation is universally adopted by the manufacturers in the country of its origin; and although obvious in their own show, in others it may be obscured by a multitude of exhibits from other parts of the world. A good example of this is the incorporation of adjustment devices for seat squabs: in some areas of the world, squab adjustment is regarded as an essential feature, whereas in others, manufacturers do not make this provision at all, because there is no demand for it locally, and they feel that the expense of adopting it for the sake of one small sector abroad is not justified. So far as technical developments of the kind just quoted are concerned, and also in respect of fashions, it should not be too difficult to solve the problem of inconsistency of requirement as between different markets. This could be done by publicity in selected areas, to create demands consistent with a greater degree of uniformity.

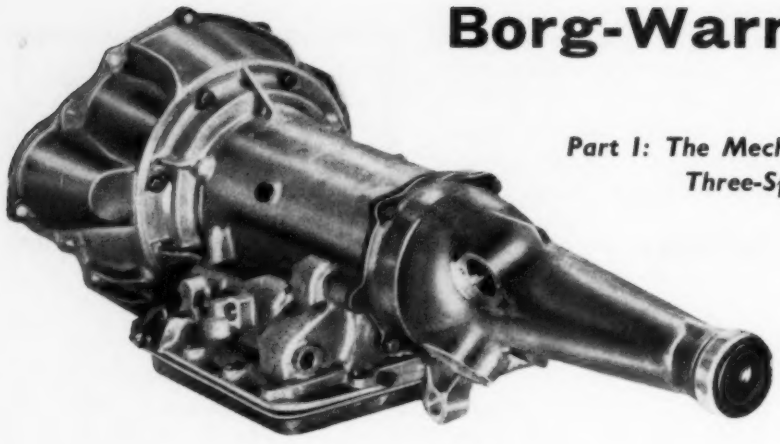
Since, throughout the world, the industry is aiming at expanding exports, trends in distant countries are just as important as those at home and, indeed, can be more so. This, of course, is the reason why representatives of design departments attend foreign as well as their own national shows. But, even in this practice, there is no common policy among firms: some send teams of as many as a dozen, whereas others are represented by, perhaps, only the technical director, and then at no more than one or two shows.

From the considerable experience that the *Automobile Engineer* staff has had in the art of gleaning information from motor shows, it has been found that one man cannot cover effectively more than a relatively small section: studies need to be made separately of engines, transmissions, electrical equipment, bodywork, and steering, suspension and brakes. Furthermore, many of these sections can be sub-divided into commercial vehicle and car categories. It follows that much can be gained by good organization of representation and collation of reports.

There are several advantages in calling for written reports. One is that, in preparing a report in this form, the observer has to examine the innovations more carefully and critically, and set out his thoughts in a logical sequence. Another is that he obtains a much deeper and more comprehensive knowledge of the latest developments and trends than he would if he were simply observing casually. Even greater benefits are obtained if all reports are collated and presented in the form of a consolidated summary to be circulated for the benefit of the whole firm. This could be a significant help in the conditions of increasing competition that lie ahead of the industry, especially in European markets.

Borg-Warner Model 35

Part I: The Mechanical Aspects of a Compact Three-Speed Automatic Unit, Intended for the Medium-Size Car



Three-quarter rear view of the Borg-Warner Model 35 unit. To minimize the weight, aluminium alloy diecastings are employed for the casing; the oil pan underneath is a steel pressing

NOW that automatic transmission systems for the larger types of car have been developed to an acceptable standard, much work is being done in Britain and other European countries to evolve satisfactory units for vehicles in the 1½ to 2½ litres category. Of the several smaller-car automatic transmissions known to be under development—and referred to in the 1960 London Show Review issue of *Automobile Engineer*—among the first to go into production is the Borg-Warner Model 35. This new unit, which is of American design, has been thoroughly investigated by a number of British and Continental car manufacturers, and will be available as an optional extra on certain B.M.C. cars, which will be exhibited at this month's London Show. For the production of the Model 35 transmission, the Borg-Warner factory at Letchworth, Herts, has been considerably extended; the facilities now available will permit an output of up to 800 units a day.

For any automatic transmission to be truly competitive with a conventional manually controlled gearbox, its penalties in terms of cost, weight and efficiency must obviously be strictly limited. The lower the rating of the unit, however, the closer these limits usually become: in the case of cars of relatively low power: weight ratios, the combination of unduly high weight and low efficiency could seriously impair the performance and economy; moreover, the price consciousness of the intending purchaser inevitably tends to increase in inverse proportion to his means. From these considerations it follows that the design problems in respect of an automatic transmission become more intractable as the engine size is reduced. Consequently, if production units of the Model 35 come up to expectations, great credit will be due to Borg-Warner Ltd, in Great Britain, by whom almost all the development work has been done, as well as to the parent firm, the Warner Gear Co.

In brief, the new unit features a hydrokinetic torque converter and a compound epicyclic gear train, controlled by a system of clutches and band brakes to provide three forward ratios and reverse. Though based on the Warner Gear Co. Model 8 unit, it differs from this in several respects: the most important of these differences are considerably reduced weight, and improvements in the hydraulic control system and the quality of the gear changes. The new unit was designed to suit engines of between 1½ and 2½ litres in its standard form; this upper limit is, of course, approximately the lower limit for the current Borg-Warner Model DG transmission. To cater for such a relatively wide range, two different sizes of converter are available. From experience gained so far, it appears that units fitted with the smaller converter should, in fact, prove suitable for use with engines as small as 1·3 litres. On the other hand, by employing higher-capacity clutches—with a small increase in the overall length and height—in addition to the larger converter, application should be practicable to engines of 3 litres or even more. This increase in the scope of the transmission offers the prospect of lower production costs.

The weight has been minimized by the extensive use of light alloys and by careful consideration to detail design. According to the manufacturers, the complete unit for a 1½ litre engine weighs 112½ lb dry, which is only 3 or 4 lb heavier than the conventional four-speed gearbox and clutch it is intended to replace. In the case of the typical three-speed gearbox, the disadvantage would be only 5 to 6 lb.

Although the maximum torque multiplication of the converter is relatively large, namely 2:1, a creditably high efficiency has been achieved. In addition, care has been taken to ensure that the mechanical losses in bearings, seals and other moving parts are as low as possible. Consequently, it is claimed that the maximum speed of a car equipped with the Model 35 transmission should be only 4 to 7 per cent lower than that of the same vehicle with a normal gearbox. Whereas fuel consumption is naturally greatly influenced by traffic and road conditions, and by driving methods, it is considered that the average penalty would be of the order of 1½ m.p.g.

An improvement over the larger Borg-Warner transmission is that a holding position, providing engine braking, is available on intermediate as well as bottom gear, whereas on the earlier unit only bottom gear can be held for that purpose. The quality of the changes has been enhanced by the introduction of an interrelation between the throttle position and the hydraulic pressure in the control system. To avoid unnecessary changes of gear, the control system is arranged so that automatic down-shifts do not occur even under full throttle, unless the throttle pedal is fully depressed through a detent, or until the road speed falls below a critical value, which is deliberately set very low. The practicability of this arrangement is due to the fact that the torque converter is operative in all gears. In fact, it is considered by Borg-Warner Ltd. that the conversion range is sufficiently wide to permit the existing final-drive ratio to be raised in some instances, with benefit to the fuel consumption.

A feature of some importance is that push or tow starting of the car is practicable in the event of battery failure or other trouble. This facility is obtained by the incorporation

of a hydraulic pump driven from the output shaft of the transmission, in addition to the one driven from the engine through the converter. In view of the current trend towards the reduction of routine servicing on motor vehicles, it is noteworthy that the common hydraulic and lubrication system is filled for life by the factory, and requires no periodic draining and refilling. According to the manufacturers, the robustness of the controls and components is such that adjustments should not normally be necessary during the life of the unit.

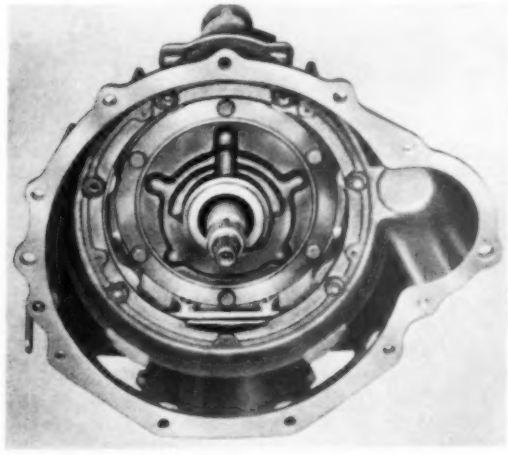
Selector positions and operational characteristics

The transmission is controlled by the usual selector lever on the steering column, and the lever quadrant has five positions, marked L, D, N, R and P. If the first of these, which is known as the lock-up position, is selected from rest, the unit will remain in low gear regardless of the speed of the vehicle or the degree of throttle opening, thus providing maximum engine braking. Selection of L when the car is in third gear, on the other hand, causes an immediate down-shift to occur to second gear. The transmission remains locked in this gear, to provide moderate engine braking, until the speed falls below about 10 m.p.h, or until the throttle pedal is fully depressed between this speed and about 20 m.p.h: in either case the transmission shifts into low gear, and again is locked in that state. For obvious reasons, L should not be selected at road speeds above about 60 m.p.h.

For all normal driving, of course, the D range is employed. In the customary manner, changes of ratio then occur under the combined influence of road speed and throttle position. There is the usual kick-down control for obtaining a lower ratio than that in use, to give maximum acceleration, provided that the road speed is below the pre-set upper limit for the lower ratio. Below the minimum speed for the upshift to second gear, the transmission freewheels in first gear. A table showing typical speeds at which gear shifts occur is reproduced on page 369.

In the N or neutral position of the selector, the torque converter continues to be driven by the engine, but the epicyclic train is free, so no power is transmitted to the rear wheels. R is the normal reverse position, in which engine braking remains effective. The only difference between P and N is that, in the former, the output shaft of the unit is mechanically locked to the casing: for the engine to be started, the lever must be in one of these two positions.

It is noteworthy that, in the interest of simplicity and minimum weight, no hydraulic interlocks are provided. Consequently, it is, for instance, possible for reverse to be engaged while the vehicle is travelling forward at speed. Since the R and D positions on the selector quadrant are separated by neutral, however, and the selection of reverse, lock-up or park involves the negotiation of baulking gates on the quadrant, the risk of inadvertent engagement is clearly very small.

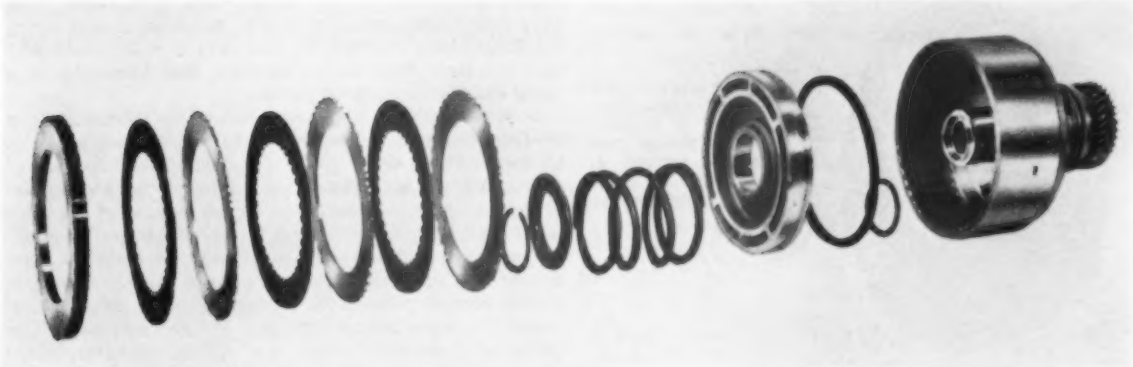


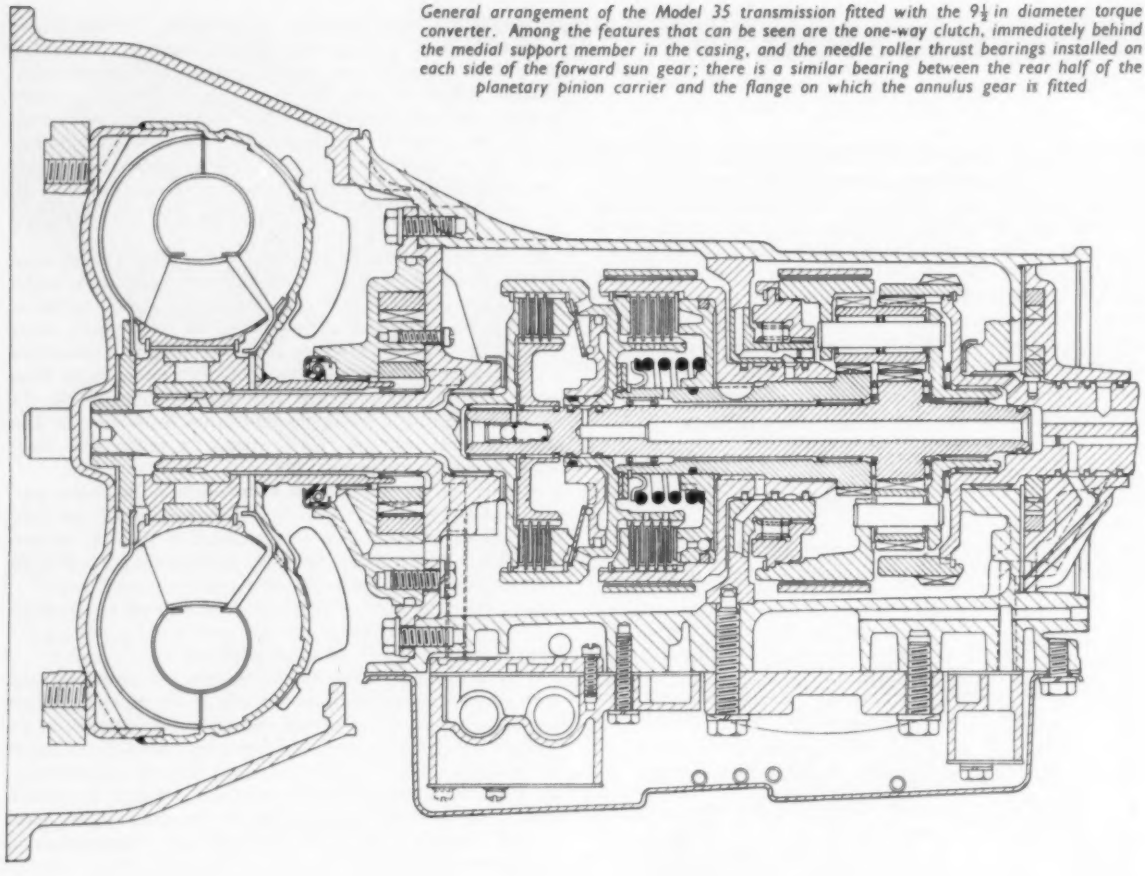
Above: This view from ahead shows the bell-housing for the torque converter, and the bolted-on, cast iron body of the front oil pump. Below: The components of the rear clutch; in both the clutches, alternate plates have facings of sintered bronze

Construction

The transmission is contained in three aluminium alloy diecastings—the bell-housing enclosing the torque converter, the casing for the clutches, band brakes and gear set, and the rear extension. Both the first and the third portions are gravity cast in a high-silicon alloy, whereas the casing is a silicon-copper alloy pressure diecasting. These castings are mutually located by spigots and are bolted together. Into the front and rear walls of the main casing are spigoted the cast iron bodies of the two hydraulic pumps, which are secured by bolts.

Approximately mid-way between the ends of the casing is a steel support member, the function of which will be

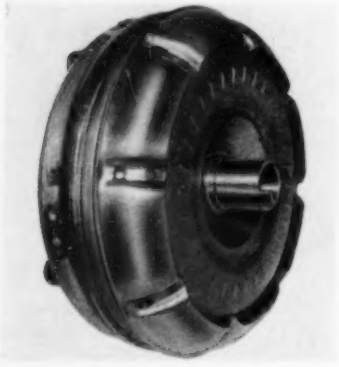




General arrangement of the Model 35 transmission fitted with the 9½ in diameter torque converter. Among the features that can be seen are the one-way clutch, immediately behind the medial support member in the casing, and the needle roller thrust bearings installed on each side of the forward sun gear; there is a similar bearing between the rear half of the planetary pinion carrier and the flange on which the annulus gear is fitted

described later. It is pushed into the bore of the casing against a shallow shoulder, and is located and secured by the dowel end of one of the bolts securing the rear servo to the bottom face of the casing; this dowel end enters a blind hole in the support member. The hydraulic fluid is contained in a pressed steel pan, which is also bolted to the underside of the casing and encloses the valve body assembly. Transmissions fitted with the smaller, 9½ in diameter, converter have a fluid capacity of 11¼ pt, whereas the capacity is increased to 14¼ pt if the larger converter, which has a diameter of 11 in, is employed.

Both the torque converters are of generally similar design, and are of the familiar three-element type. As can be seen from one of the accompanying illustrations, the units are fabricated from steel pressings, with the exception of the stator of the 9½ in converter, which is an aluminium casting. The input member is to the rear of the runner and its casing is extended forward to overlap the flange of the frontal pressing of the converter, to which it is welded. In the centre of this pressing is a welded-on spigot peg, which enters an axial hole in the crankshaft flange to locate the assembly thereon. Four bolts secure the casing to a drive plate, which embodies the starter ring gear and is also bolted to the crankshaft flange.



To increase the scope of the transmission, an 11 in diameter torque converter, seen here, is available as an alternative to the 9½ in diameter version

The stator member of the converter is mounted on the end of a long, hollow boss that projects forward from the pump adaptor on the front wall of the transmission housing. Within this boss are two plain bearings, of the steel-backed babbitt type, carrying the runner shaft. This shaft is an alloy steel forging, and is splined at its leading end to accept the flanged hub to which the runner is riveted. At its rear end, the shaft increases in diameter, and terminates in a radial flange with a splined periphery.

In a counterbore in the rear end of the runner shaft is another steel-backed babbitt bearing for the leading end of an intermediate shaft, which is an alloy steel forging of carburizing grade. Located on splines at the leading end of this intermediate shaft is the driven member of the front clutch, and integral with it near its rear end is the "forward" sun wheel of the gear train, which will be described later. Behind this sun wheel, the intermediate shaft is carried in a plain bearing mounted in the rear half of the planet pinion carrier, to which further reference will also be made. The extremity of the shaft, which is of reduced diameter, enters

a counterbore in the leading end of the output shaft. Since both these shafts are drilled to provide passages for the hydraulic fluid, which passes from one to the other, the counterbore is sealed by a ring installed in a groove round the intermediate shaft.

The driving or outer member of the front clutch is a grey iron casting of relatively complex shape, since it embodies part of the rear clutch, which is in tandem with the front unit. In essence, this casting consists of a radial web portion with two annular flanges, one projecting forward and the other to the rear. The first of these flanges is at the periphery and forms the drum of the front clutch; the other is of smaller diameter and constitutes the inner member of the rear clutch. A central boss in the web portion bears on the sealing rings for the front clutch, carried in grooves round the intermediate shaft.

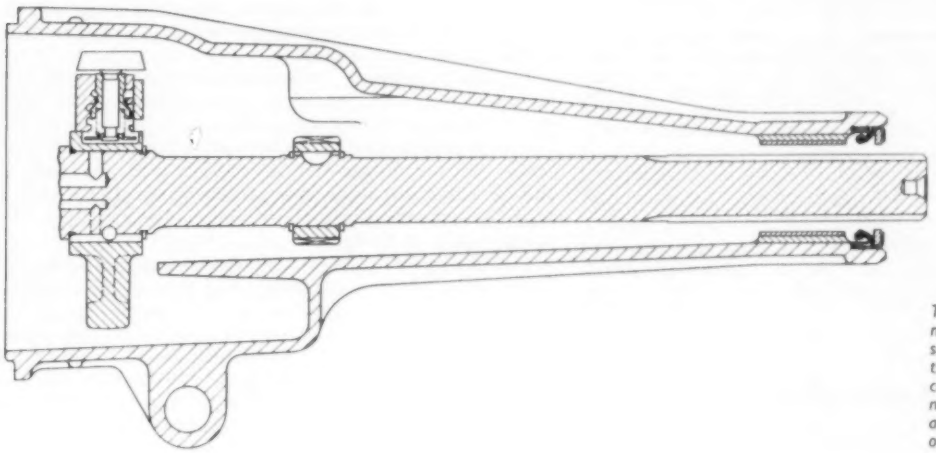
Internal splines in the leading flange register on the splined flange of the runner shaft, and also locate the peripheral dogs of the three plain steel driving plates of the front clutch. The four driven plates, which have internal dogs registering in splines on the clutch centre, are also of steel but have bonded-on, circumferentially grooved facings of sintered bronze. Although the rear clutch is generally of similar design to the front one, it has five plates of each type, and differs in respect of the spring loading: a dished, plate type spring is employed for the front clutch but the rear unit features a helical spring. The spring loading in both instances is towards the disengaged position, so the clutches are engaged by the application of hydraulic pressure.

In the case of the rear clutch, the outer member—which of course is the driven one—is also made of grey iron; its exterior serves as the frictional surface for the front band brake, and its boss is keyed to a sleeve. This sleeve, an En.4 forging, runs on the intermediate shaft; mounted in its bore are a needle roller bearing at the front and a steel-backed babbitt type plain bearing at the rear. Integral with it, and at its rear end, is the "reverse" sun gear of the epicyclic train. The hydraulic piston that actuates the rear clutch is a sliding fit on this sleeve, near its leading end, that for the front clutch being carried on the intermediate shaft.

As can be seen from the general arrangement, the boss of the driven member of the rear clutch is embraced by that of the medial support member, to which reference was made in the second paragraph of this section; there is an annular space between the two. This space forms part of the hydraulic distributional system and is divided by three sealing rings, carried in grooves on the inner boss. The other boss, which projects rearward from the web portion of the support member, is in turn encircled by a sleeve member that is attached to the pinion carrier of the gear set: there is a considerable radial gap between the boss and the sleeve, to accommodate a one-way clutch of the sprag type.

The pinion carrier, a pearlitic malleable iron casting, comprises an outer drum and a web that forms a mounting for the leading ends of the fixed spindles of the planet pinions. The exterior of the drum portion forms the frictional surface for the rear band brake. Both the band brakes are identical, incorporating a new and very effective paper-based friction material. However, the hydraulic servos that actuate the bands differ in several respects, of which the most important is that the front servo, which is released whenever the rear clutch is applied, is of the double-acting type—being both applied and released by hydraulic pressure—whereas the rear unit is released by a spring when the fluid is exhausted from it.

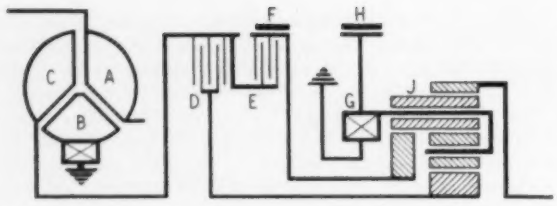
There are six planetary spindles, disposed as three pairs;



The governor assembly is mounted on the output shaft, immediately behind the rear oil pump; it is counterweighted to minimize vibration. There are alternative designs for the output shaft and extension

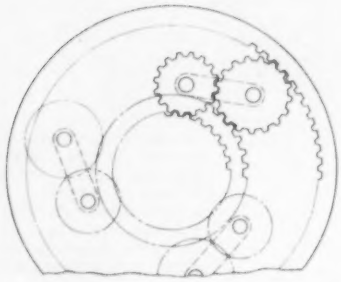
Table I—TYPICAL APPROXIMATE SPEEDS FOR GEAR SHIFTS

Condition	Road speed—m.p.h.				
	1 to 2	2 to 3	3 to 2	3 to 1	2 to 1
Selector at D—					
closed throttle	6	13	6	—	2
full throttle	20	40	15	2	2
kick-down	31	55	45	25	25
Selector at L—					
closed throttle	—	—	Above 8	8	8

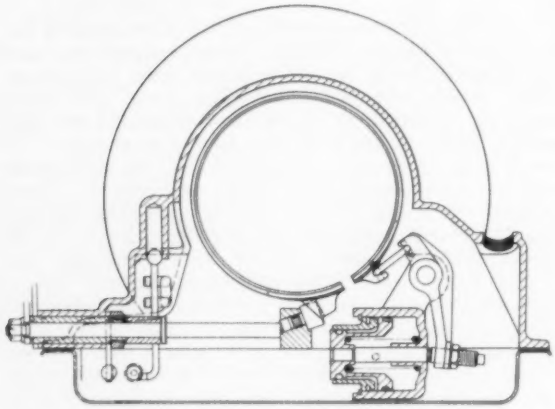


A input member of torque converter; **B** stator; **C** runner; **D** front clutch; **E** rear clutch; **F** front band brake; **G** one-way clutch; **H** rear band brake; **J** epicyclic gear train

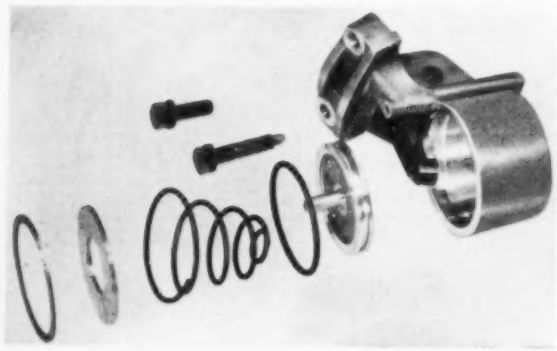
Diagrammatic view of the operating elements of the transmission. For first gear, D and H are both applied in the lock-up position of the selector lever, whereas in the drive range D and G are functioning. In either range, second gear is engaged by the application of D and F; for top gear, however, F is released and E is applied. The reverse condition of the transmission involves the application of both E and H



The epicyclic train consists of two sun gears, three pairs of planetary pinions and an annulus gear. All the tooth numbers are specified in the text



Above: Transverse sectional view of the front band brake and its actuating servo, which is of double-acting design. A new type of friction material, with a paper base, is used. Below: In contrast with the servo of the front band brake, that of the rear assembly is a single-acting unit; the piston is returned by a conical spring



their leading ends are pressed into the carrier, and their rear ends into the flange of a supporting member situated behind the forward sun wheel. On one spindle of each pair is a double pinion, and on the other is a single, smaller pinion. The pinion bearings are of the needle roller type. Of the double pinions, the leading portions mesh with the reverse sun gear only, while the second ones mesh with the annulus gear and with the single pinions, which in turn are in mesh with the forward sun wheel. The annulus is mounted on a flange that is integral with the output shaft of the transmission, which it therefore drives, and on its periphery are teeth for engagement by a pawl when the selector lever is moved to the parking position.

For all the pinions, SAE 4047M steel is employed, and the annulus is a forging of the same material. The gears are of the single-helical type, with a helix angle of 25 deg 13 min 2 sec, an involute tooth form and a diametral pitch of 16. On the reverse and forward sun gears there are 32 and 28 teeth respectively; both portions of the double pinions have 17 teeth, the single pinions have 16 teeth, and in the annulus there are 67 teeth.

The leading end of the output shaft has a double-diameter counterbore. In the larger-diameter part of this counterbore is a plain bearing, within which runs the boss of the flanged member carrying the rear ends of the planet spindles; there is another plain bearing between the bore of this boss and the intermediate shaft. The smaller-diameter portion of the counterbore has already been referred to, as housing the rear end of the intermediate shaft.

Steel to SAE 8620 specification is used for the output shaft, the leading end of which is supported in a plain bearing pressed into the bore of the rear wall of the transmission casing. Aft of the wall, the shaft is embraced by the long boss of the bolted-on rear hydraulic pump; in this portion of the shaft are three grooves carrying sealing rings which bear on the bore of the boss. The lands between these rings comprise part of the oil distributional system to and from the centrifugal type governor, which is mounted on the shaft immediately behind the boss just mentioned. An interesting detail of the governor, which will be dealt with in greater detail in Part II of this article, is that the working assembly is counterweighted to minimize vibration. On the output shaft, further to the rear, is a nylon gear for the speedometer drive, which is taken from the rear extension of the transmission casing, in the orthodox manner. Various designs of extension are available to suit the vehicle manufacturer's preference in respect of the length and the bearing arrangements for the propeller shaft.

Hydraulic pumps

Both pumps are of what can best be described as the eccentric gear type; in effect, this type is an epicyclic variation of the conventional gear pump. The driving gear is mounted coaxially on its shaft, and the driven gear, which is larger and of annular form, is free to revolve in the body of the pump about a parallel axis. Consequently, the two gears mesh over a relatively short arc, and are separated for the rest of their circumferences by a crescent-shape space. This space is almost filled by a baffle member of similar shape, and the oil is carried round in two streams, between the teeth of each gear and the edges of the baffle, from the intake to the outlet port.

In the case of the front pump, which has the larger capacity of the two, the driving gear is mounted on a bush; it is driven by the hub that projects rearward from the torque converter. This bush embraces the extended boss of the pump adaptor, previously mentioned as providing a mounting for the stator member of the converter. The driving gear of the rear pump is located on the output shaft against a shoulder, and the drive is transmitted to it by a key. In

the front pump, both gears are made of a medium carbon steel, which material is also used for the driven gear of the rear pump; the driving gear of the rear pump, however, is of sintered iron. It is noteworthy that, to prevent scuffing, the Parco-Lubrite treatment is applied to the steel gears.

Power flow

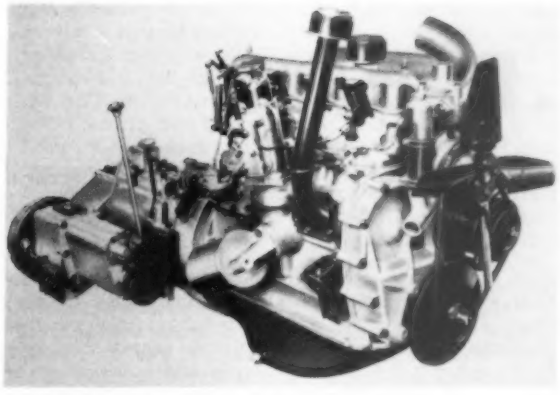
The power flow in the various conditions of the transmission is shown in an accompanying diagrammatic illustration. When D is selected and first gear is engaged, the front clutch is applied, thus connecting the runner of the torque converter to the forward sun gear; the rear clutch and the two band brakes are released. Rotation of the pinion carrier in a direction opposite to that of the engine is prevented by the one-way clutch, so the gear train provides a ratio of 2·39 : 1 when the engine is pulling. On a trailing throttle, though, the pinion carrier over-runs and the gear train free-wheels.

This free-wheeling in first gear not only ensures a good quality of change between the lower two ratios but also confers greater smoothness of the drive in dense traffic, because of the absence of engine braking. When full engine braking is required, L is of course selected: in the first gear condition of this range, the rear band is applied to hold the carrier stationary on both drive and over-run. The application of the band clearly does not affect the gear ratio.

In second gear, the power flow is the same whether the control lever is in the L or the D position. The front clutch is applied, as in first gear, so the torque converter is again connected to the forward sun gear. By the application of the front band brake, the reverse sun gear is held stationary, and so the gear set provides the intermediate ratio of 1·45 : 1. The engagement of top gear is effected by releasing the front band and applying both the front and rear clutches, thereby connecting the runner of the converter to both the forward and reverse sun gears. It follows that these gears are locked together, the gear set rotates as a unit, and the ratio is therefore 1 : 1.

When either the neutral or parking position is selected, the front and rear clutches are disengaged, so no power is transmitted from the converter to the gear set; the front and rear bands are also released. For reverse, the rear clutch is applied, to couple the converter to the reverse sun gear. Since the rear band is applied as well, holding the pinion carrier stationary, the gear set provides a reduction of 2·09 : 1 in the reverse direction of rotation.

Larger Diesel Engine for Land-Rovers



In external appearance, the new 2·3 litre Rover diesel unit differs little from its smaller predecessor. However, several modifications have been made, and the specific power output has been raised from the previous 25 b.h.p/litre to 27·1 b.h.p/litre, or over 8 per cent

AFTER a production run of about four years, the Land-Rover 2 litre diesel engine is to be replaced by a more powerful unit with a swept volume of 2,286 cm³. Although the new engine is basically similar to its predecessor, it differs from it in several important respects. The increase in swept volume has been obtained by enlarging the bore from 85·725 mm to 90·475 mm, without alteration to the existing stroke of 88·9 mm.

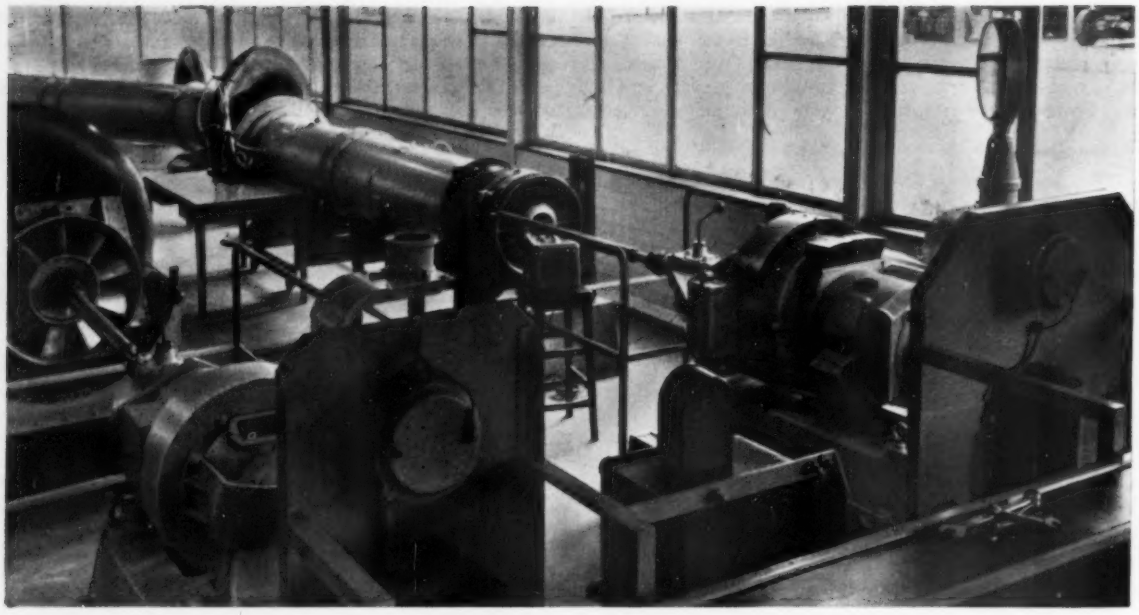
Because of the greater power and torque, to which reference will be made later, the three-bearing crankshaft has been stiffened by increasing the diameter and fillet radii of the crankpins. The crankpins of the smaller engine have a nominal diameter of 2·125 in and a fillet radius of 0·100 to 0·110 in, whereas the corresponding figures for the 2·3 litre unit are 2·312 in and 0·140 to 0·150 in. It is noteworthy that, in the new block, the cylinder bores are integral, whereas wet liners were previously employed; tests have shown the integral bores to have a longer life than the liners. No change has been made to the four-bearing camshaft or its duplex roller chain drive, which incorporates an automatic tensioner sprocket.

As before, Ricardo Comet V combustion chambers are employed, but they embody a Rover provisional patent that was developed in the 2 litre engine and has been further modified for the new unit. This patent covers the incorporation of pimples on the surface of the chamber, their purposes being to improve the heat transfer between the surface and the gas, and to assist mixing of the air and fuel; the better mixing reduces noise by shortening the delay period, and permits a more retarded injection timing without loss of efficiency. It has been found, too, that this feature facilitates low-temperature starting. The compression ratio is relatively high at 23 : 1.

It will be recalled that the Rover 2 litre diesel engine was one of the first to be fitted with the C.A.V. DPA distributor type fuel pump. A speed-sensitive, automatic advance device is now embodied in the pump. It has an operating range of 5 deg of the crankshaft, and its use has enabled the maximum full-load speed of the engine to be raised from 3,500 to 4,000 r.p.m.

Other modifications include the adoption of a heavier flywheel, of 8 per cent higher inertia, and of a larger fan and a radiator of increased capacity. In addition, the sump flange has been stiffened and the rear oil seal of the crankshaft is of a new and more efficient type. The last-mentioned modification has been made to ensure satisfactory sealing when the vehicle is operating on steep slopes for lengthy periods.

In the case of the 2 litre engine, the power output and torque were respectively 51·2 b.h.p. at 3,500 r.p.m, and 87 lb-ft at 2,000 r.p.m. Since the larger unit produces 62 b.h.p at 4,000 r.p.m. and 103 lb-ft at 1,800 r.p.m, the increase of approximately 11 per cent in the swept volume has been accompanied by gains of 21 per cent in the power output and 18 per cent in the torque. The fuel consumption in service has not been appreciably altered, and about 28 m.p.g. should be obtainable in average circumstances.



General view of the cooling fan and air filter section of the engineering test laboratories, showing the rigs that are used for testing the fans

F.V.R.D.E.

Part II: The Engineering Test Laboratories and the Trials and Development Services Division

THE engineering test laboratories of the F.V.R.D.E. at Chobham, which are the responsibility of the Deputy Director in charge of research, offer a common service to the various design departments of the Establishment. They form a self-contained unit under their own Superintendent and, in relation to the enormous range of work undertaken, their staff is by no means large. Whereas the employment of a relatively small staff does avoid redundancy during quieter periods, it also results in considerable pressure when several major projects are being undertaken simultaneously, as frequently occurs.

At present, the nominal strength of the department is 43. This figure includes the Superintendent and also the works manager, who is responsible for the operation and maintenance of the plant, and the manufacture of any special rigs and equipment required for test purposes. The department has a well-equipped small machine shop with limited workshop facilities, any job beyond their scope being passed to the main workshops described in Part I of this article.

In charge of the various projects, of which as many as 200 may be in hand at any one time, are four qualified chartered engineers. Under them are eight unchartered technical engineers who are directly responsible for the work carried out in the laboratories by 24 men of the so-called industrial grades—mechanics, labourers and storemen. Because of their small number, the mechanics are deliberately encouraged to become proficient in as many different aspects of the work as possible. This generalization, as opposed to specialization, has two objectives: it stimulates interest in the work, by avoiding any tendency for an employee to get into a rut, and it minimizes continuity difficulties due to the wide range of test work involved, and to holidays; clearly, with an organization of this type, there can be no general shut-down in the summer. A shorthand typist and a clerical officer deal with all correspondence and reports for publication.

The remaining members of the staff are employed in the drawing office, and consist of a senior draughtsman and four draughtsmen. Their primary task is the designing of rigs and other apparatus for the test work. However, they are also concerned with the illustration of failures that occur on test, for inclusion in reports, and in some instances with preparing drawings of suggested modifications to avoid further failures.

A detailed survey of the facilities and methods used in the engineering test laboratories was given in the June 1955, issue of *Automobile Engineer*, in an article by the Superintendent. Although much of this description is still valid, there have been sufficient changes to warrant an independent review of the department and its work. Before turning to this, though, it may be of interest to recapitulate the main reasons—given in the article just mentioned—for the decision, taken early in 1941, to establish these laboratories. Apart from their obvious advantages for *ad hoc* investigations, controlled laboratory tests are valuable in the following circumstances:

(a) when an operational run of several hours' duration is needed to establish steady conditions
(b) when inaccessibility after installation in the vehicle

concerned makes observation of the test component or assembly impossible

(c) when it is inconvenient to convey vehicles, equipment, supplies and personnel to a suitable natural test site

(d) when there would be delay in the occurrence of suitable natural test conditions.

Briefly, the engineering test laboratories include sections for the testing of fans and air filters, tyres, engines, transmissions and suspensions. In addition, there are tropical and cold chambers, a vehicle dynamometer installation, a general test room for complete vehicles, a shock test section, and an instrument store and calibration section, in which minor repairs can be effected. The buildings in which the laboratories are housed were built mainly during the war, but additions have been made more recently to increase the facilities.

During the earlier years, a considerable amount of work was done in the fan and filter laboratory to evolve really accurate and consistent test methods. This programme was regarded as essential because of the discrepancies that frequently occurred between the performance figures obtained in the laboratory and those quoted by manufacturers. It is worthy of mention that some of the special rigs and methods developed have since been adopted by industry.

For fan testing, the basic method is to fit the unit to the end of a cylindrical duct, drive it, and measure the air output by means of a pitot-static device. Normally, the fan is driven by a motoring dynamometer, and the speed is varied by an automobile gearbox. Wooden bell-mouths are fitted to the fan assemblies to provide a smooth entry for the air.

A difficulty encountered earlier in air filter testing was to provide a consistent and accurately metered flow of the sand used, so a special technique of sand feed was evolved which, incidentally, was subsequently taken up by a well-known manufacturer of filters. From the metering device, the sand is fed directly into the filter on its test rig, the rate of flow being directly related to that at which the air is sucked through the unit by a centrifugal fan; this air throughput is measured by means of an orifice plate and manometer. Since the weight of sand delivered in a given time is known, the efficiency of the filter can be calculated from the difference between the weights of the filter before and after the test.

For accuracy in filter testing, the sand used must be of a consistent specification and very carefully weighed. The sand analysis methods developed at Chobham eventually formed the basis of a DTD specification, and were valuable in the preparation of B.S.1701. Weighing is done on a large Webb balance having an accuracy of one part in 150,000. Another essential in this work is the efficient cleaning of the filter elements after testing, and this is done in a special shop. Although the present method of filter testing is both accurate and reliable, improved ones are now under development.

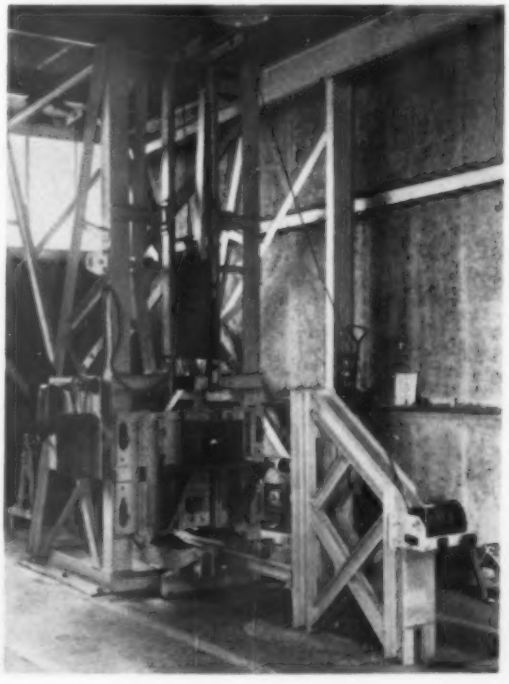
In the tyre testing shop are three drum type test machines, which are generally similar to those used by the Dunlop Rubber Co, Ltd. Of the three, the largest can apply a load of up to 10 tons and it accommodates one or two tyres; if two are to be tested simultaneously, they are mounted diametrically opposite each other; though their peripheral speeds must clearly be the same, they can be differently loaded. The other two machines, which are identical with each other and can apply a maximum load of 3 tons, each have two drums, mounted on a common shaft. Two tyres can be tested at different loads at the same time, one on each drum.

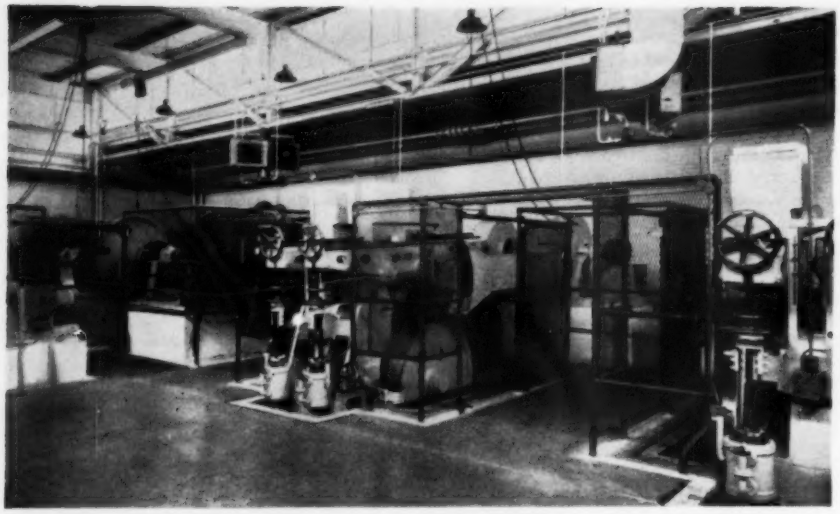
On all three machines, speeds of up to about 70 m.p.h. are obtainable, and there is a separate cooling air system for each tyre. The speed of the air can be adjusted to any desired value, independently of the drum speed, so that allowance can be made for the blanking effect of mudguards or other parts of the vehicle concerned. Tyre temperatures are measured by the usual method of a small thermocouple housed in a hypodermic needle. The large number of tests carried out in the laboratory has enabled a correlation to be found between the temperatures developed on the machines and those obtained on the road. Since, by virtue of this correlation, the optimum tyre size for a given duty can be determined, vehicle manufacturers' proposals regarding original equipment for a new vehicle can be verified.

Another machine in the tyre laboratory is for the testing of resistance to impact. A weight carrying a spike is dropped on to the tyre from a predetermined height, and the rebound is measured; the drop is repeated until failure of the tyre occurs. The length of the spike is adjusted before the test, to ensure that it does not fully penetrate the plies, and the height of the drop is varied with the size and type of tyre. A maximum drop of 15 ft is practicable, and the machine has a capacity of 3,000 ft-lb. Tread prints and tyre deflection under load are measured on a large Avery platform weigher, the capacity of which is 6 tons.

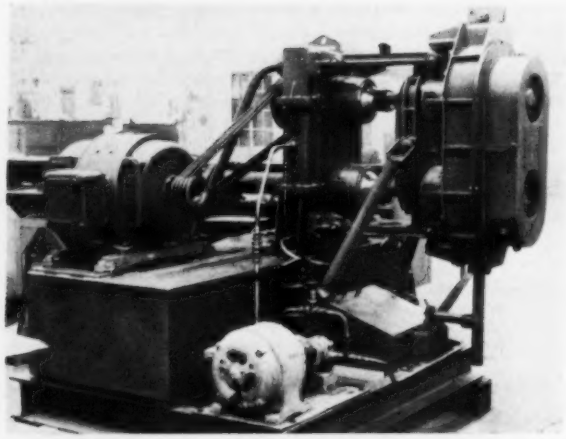
When this article was being prepared, an extensive reorganization of the engine test facilities was taking place. Originally, some of the dynamometers were of the water brake type, but eddy-current units are replacing these for all the static beds. Several water brakes will, however, be retained for special tests. The space within the building occupied by the water cooling towers for the superseded water brakes is being given over to an additional 400 h.p. test bed, and the recent removal from the test shop of the vehicle dynamometer installation—to which reference will be made later—to another site has further increased the capacity of this laboratory. When the changeover is completed, there will be a range of dynamometers suitable for the testing of engines of all types and of up to 1,000 h.p. It is worthy of mention that the standard method adopted for insulating the concrete base blocks of the beds is to install a 2 in layer of cork beneath the block and around all four sides.

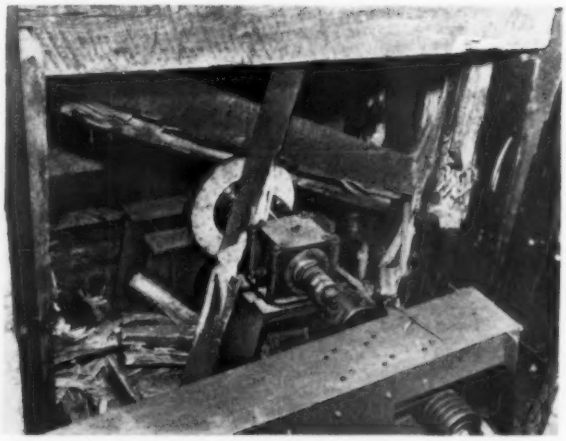
An important branch of the work of the laboratories is shock testing, which is carried out on this machine. For vertical impacts, a weight is dropped on an anvil adjacent to the test item, whereas the other loadings are applied by a pendulum



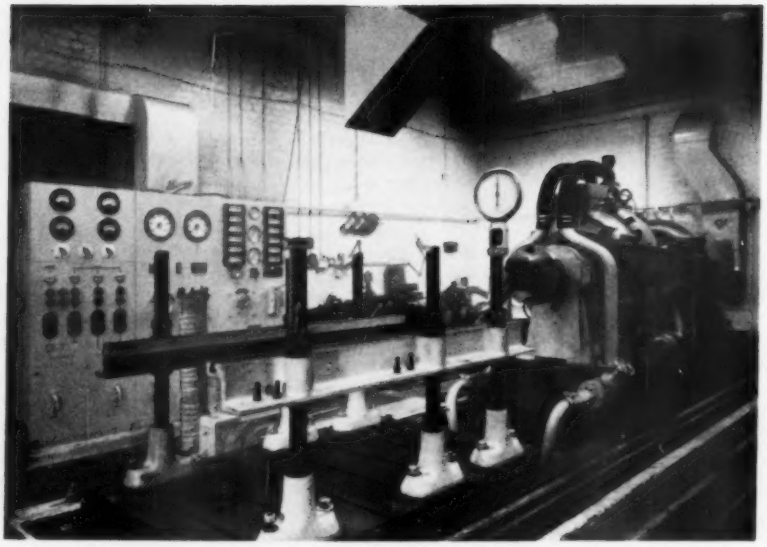


There are three machines of the drum type in the tyre testing laboratory; the nearer two are of identical design, the third being larger. Each machine can accommodate two tyres at a time, and the cooling air supplies to them are separately adjustable





Above: A noteworthy feature of this rig for testing the Chobham constant-velocity universal joints is that the torque is locked into the system; the electric motor only has to overcome the internal losses. Above right: When a clutch is tested to destruction in the burst chamber, a large amount of damage can be caused. Records of bursting tests can be obtained by the use of a cinematograph camera, which is aimed through a slot in the armoured wall



In the engine test laboratory is a wide range of eddy-current dynamometers, one of the largest of which is this 1,000 h.p. unit. The base block is insulated from its surroundings by a 2 in cork layer

In the test shop for transmission units and suspension components, which adjoins the engine laboratory, there are eddy-current dynamometers of various sizes for trials of gearboxes, fluid couplings and blowers. For testing the Chobham constant-velocity universal joints, a very ingenious method and rig has been evolved by the staff of the Laboratories: by means of the rig, the joints can be run at full torque, and at any desired speed, without the need of a large external source of power. Two shaft and joint assemblies are used, coupled together at each end by gears to form a closed circuit. The gears of each train are enclosed in an oilbath case.

One of the gear trains is mounted on the rig and is connected to a 12 h.p. variable-speed electric motor. The other is carried on vertical swivels on two wishbone links attached to the rig, so that it can be set to simulate any desired suspension or steering deflection. By means of a loading bar and a muff coupling, the desired torque is pre-loaded into the closed circuit, the two shaft and joint assemblies then working in opposition. Thus the electric motor has only to overcome the friction in the bearings, joints and gears of the system.

This principle of loading in opposition has also been used for testing final-drive gears and is currently employed for suspension torsion bars on another machine in the same shop. As one of the bars is unloaded the other is loaded, the net torque in the system remaining constant. The fluctuating deflection is applied by means of arms, mounted on the free ends of the bars, and a crank and connecting rod system actuated by a 15 h.p. variable-speed electric motor. Adjustments can be made to the throw, and the connecting rod length, to give the desired range of twist, which can be up to 70 deg. The bars work all the time in the positive load range, and they are twisted in opposition before the rods are coupled to the arms.

For the investigation of torsional and vibrational effects on chassis, this laboratory is equipped with a large drum dynamometer. There are two drums, each of 5 ft diameter, and one or both can be used for test purposes. On the drums, which are driven by a 50 h.p. electric motor and have a maximum peripheral speed of 70 m.p.h, are mounted cam segments that provide the required deflection. A maximum lift of 6 in is practicable, and each drum can carry up to four segments. The equipment is also used for testing the resilient wheels referred to in Part I of this article, in the section on research. In this case, the wheel concerned is fitted in place of one of the drums and is loaded from above.

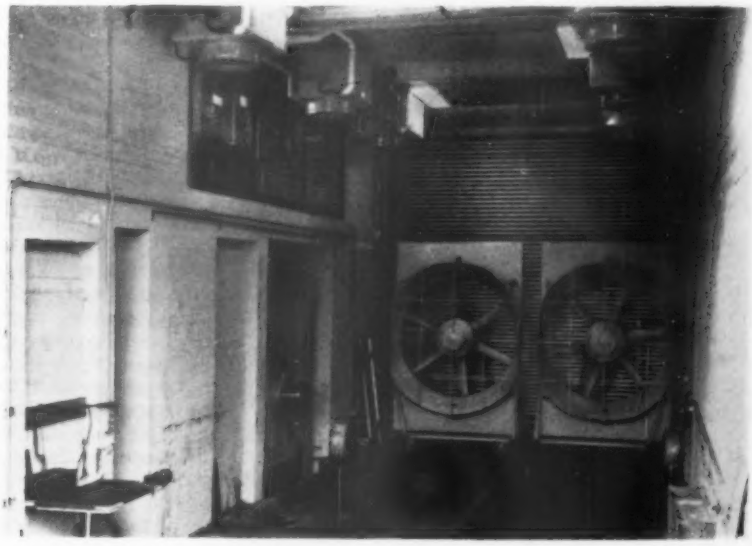
Bursting tests are sometimes desirable to ascertain the margin of safety of clutches, brake drums or fans. These tests are performed in this shop, in a special pit protected by armour plate. Components weighing up to ½ cwt can be run on the rig, which embodies a variable-speed electric motor and gearing to give a maximum output speed of 9,000 r.p.m. A cinematograph camera can be directed through a slot in the armour plating, to obtain a record of the tests.

The shock testing machine is also housed in this section of the laboratories. It is hardly necessary to point out that a fighting vehicle is likely to be the target of ballistic missiles, and it is of little use to have a hull that resists explosions if the equipment it carries is rendered useless thereby. It follows that really effective shock-absorbent mountings are essential for delicate items such as instruments, radio sets and gunnery apparatus. Very careful attention is given in the design department to the layout of these mountings, and each type produced is thoroughly tested.

By means of the machine installed, it is possible to apply shock loading in all three planes. For vertical loadings, the unit under test is bolted to a plate carrying a steel anvil; the supporting structure of the plate is mounted on leaf springs, to minimize the transmission of the impact to the floor. The loading is produced by dropping a steel block on to the anvil. To give a consistent and clean release of the block, the hoisting mechanism incorporates an electromagnetic chuck. Various blocks, the heaviest of which weighs 56 lb, are used, depending on the nature of the test. The block is guided during its fall, which can be through any distance from 6 in to 5 ft.

Lateral loading is applied by a heavy pendulum, which has a maximum angle of swing of 70 deg. The pendulum arm is of fixed length, but the weight on it can be varied as required for any particular test, with a maximum of 56 lb. After rotation of the anvil holder plate horizontally through 90 deg, this pendulum is used to produce longitudinal shock loading.

Numerous purposes are served by the tropical chamber, among them the investigation of the efficiency, at various temperatures and humidities, of air conditioning plant for



The dynamometer tunnel used for testing tanks and other large vehicles was built in a disused wading trough, to minimize transmission of noise. There are two 500 h.p. water dynamometers, one at each side; the control room, which has double glazing, can be seen at a higher level on the left

personnel and equipment. Fire fighting apparatus and electrical gear can be tested under actual operating conditions, and both the corrosional and starting characteristics of gas turbine power units can be studied. Not the least important function of the chamber is to enable reliable data to be obtained regarding the liability of the growth of mould spores on fabrics and other materials.

The chamber is 36 ft long × 20 ft wide × 16 ft high, and it has a full-size opening at one end to permit the entry of large vehicles. A combination of steam radiators and solar ray lamps is employed to produce the desired conditions. The number of lamps in use is governed by the size of the equipment under test, but sufficient are available to generate 360 B.Th.U/ft²-hr. To minimize the rate of heat loss, the walls and roof are insulated by a 9 in layer of cork.

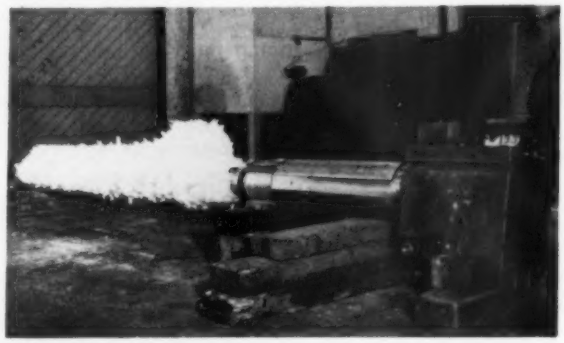
For the measurement of power, if necessary, during running tests, a water brake can be installed, and there are facilities for leading exhaust gases outside the building. A new technique of temperature raising, in which the solar ray lamps are replaced by heaters of special design, is under development, but nothing further can be said about it at this stage. At present, temperatures of up to 200 deg F can be generated, with strictly controlled humidity, and saturation is possible at temperatures as high as 125 deg F. The temperature control is accurate to within ±2 deg F, and that of humidity to within ±1 per cent.

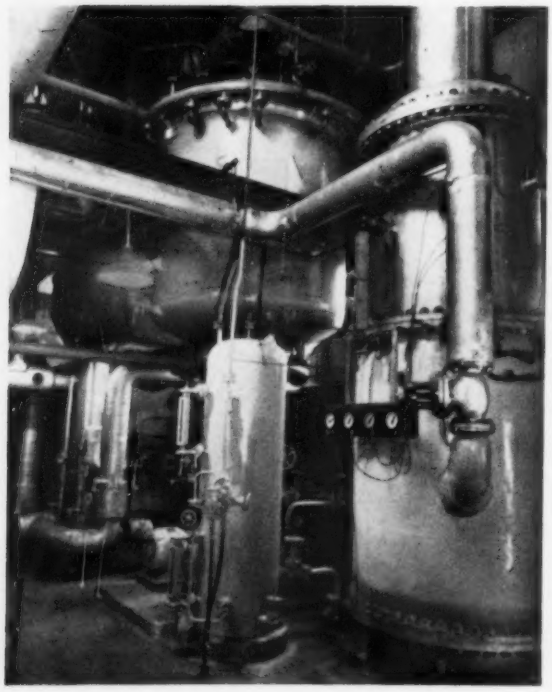
In view of the high temperatures in which the tropical chamber personnel have to work, deconditioning is effected before they go out into the open air. On leaving the chamber, each man spends a minute or two in an adjoining one, maintained at an intermediate temperature. He then goes to the shower room, which is rather cooler, and is expected to finish his ablutions with a cold shower, to close the pores of the skin. After the shower, he dresses and spends at least 15 minutes in the rest room—at normal indoor temperature—before going outside. In the normal way, the deconditioning takes a minimum of half an hour, and the excellent health record of those concerned is certainly a tribute to its value.

Having regard for its temperature range, the cold chamber is thought to be one of the largest in the country: its measurements are 32 × 32 × 16 ft and the door size is 12 × 12 ft. Its refrigerating plant can extract 600,000 B.Th.U/hr, which results in the attainment of ambient temperatures down to −40 deg F, or even lower if the cooling load is small. This plant is of the absorption type, which has a superior performance to the vapour-compression type at very low temperatures. From the serviceability viewpoint, there is the additional advantage of no working parts other than the brine pumps and the air fans. To obviate internal icing of the plant, the air is dried before being cooled, by passing through concentrated brine.

A double air-lock entrance minimizes the refrigeration loss caused by members of the staff going into or out of the chamber. To enable running tests to be done, an eddy-current dynamometer is installed in an adjoining room, with a shaft extension through the wall into the cold chamber. This dynamometer has an absorption rating of 175 h.p, and can provide 70 h.p. for motoring.

When engines are being run, it is essential that pollution of the air by exhaust gases be minimized. Should the pollution exceed a safe level, it would, of course, be necessary to change the air completely, and therefore subsequently to re-cool the chamber. On this account the equipment includes a CO indicator, and tests are carried out regularly for the presence of other contaminants.





Left: The refrigeration plant for the cold chamber operates on the absorption principle, and has a high extraction capacity. Above: Among the effects that can be studied in the cold chamber is ice accretion, in this instance on the barrel of a large-calibre gun

There are no stringent regulations for the welfare of those working in the cold chamber. Special clothing is, of course, worn whenever the exposure to low temperatures is to be prolonged; this clothing is of the pattern currently used by the armed forces. In addition, workers are encouraged to come out for a warm-up as soon as they begin to feel chilled or to lose sensation in their fingers. It is worthy of comment that the men working in this section are among the healthiest in the Establishment.

The construction of the chamber is of interest in a number of respects. Freezing of the ground, with the consequent risk of cracking of the foundations, is avoided by having a concrete sub-floor built on piers, with an air space between it and the main foundations. Above this sub-floor is a 9 in thick layer of cork, on top of which is the chamber floor. The walls and roof are also insulated with 9 in of cork applied in three 3 in layers with staggered joints. Under the roof is a dummy ceiling, and the air supply duct is led from the refrigerating plant through the intervening space.

In the roof are installed the steam batteries for defreezing

General view of the suspension test courses on the track that forms part of the Establishment. The pavé is considered to be as severe as that at M.I.R.A. In the middle are a boulder course and one—the nearer—in which iron domes are incorporated. A slatted course is on the right

the chamber when necessary. By using this heating plant, it is in fact possible to carry out hot as well as cold tests in the one chamber. However, an ambient temperature of 120 deg F must not be exceeded, or softening of the bitumen sealer used for the cork is likely to occur.

The vehicle dynamometer tunnel is constructed in a disused tank wading trough. As was mentioned earlier, it was originally in the main building, but the noise was distracting to workers in other sections, and even to local residents; in addition, rebuilding was needed to meet future requirements. The estimated cost of rebuilding and of effective sound insulation was found to be so high that it was decided to use an alternative site. Experiments revealed that, thanks to the depth of the wading trough, and the steepness of its end ramps, the noise generated by a tank on an endurance run at full throttle was not troublesome in the nearest shop.

As an indication of the care taken by the F.V.R.D.E. to minimize the expenditure of public money, it should be recorded that the total cost of fitting out the trough, installing whatever new equipment was needed, and transferring the existing plant to the site, was approximately a third of that quoted for modifying and sound proofing the old tunnel.

In the tunnel, which has a steel floor, the temperature and humidity of the air are controlled. The vehicle under test is anchored to the floor and is coupled to two water dynamometers, one on each side, which have a combined absorption capacity of 1,000 h.p. To keep the static temperature of the vehicle down to the desired level, there is a battery of mobile electric fans on stands. These fans can be used either as recirculators or to provide a fresh-air system, by closing or opening louvres in the end doors of the tunnel. All the controls and instruments are situated in a double-glazed control room above the working section of the tunnel.

The remaining section of the laboratories consists of a general test chamber for complete vehicles and equipment. It contains a drum dynamometer of 400 h.p. absorption capacity, and so is used for testing the smaller types of vehicle that cannot be set up in the tunnel. Heating apparatus is used to generate elevated ambient temperatures, of up to 160 deg F, but there is no humidity control. A large ducted fan, on a mobile mounting, provides a recirculatory air flow to simulate vehicle movement. In this way, it is possible to test the performance of air conditioning and other equipment in circumstances approximating closely to those obtained during service.

The normal instrumentation and controls are installed in an air conditioned, glass fronted cabin at the side of the chamber, adjacent to the dynamometer. Since the chamber is asbestos lined, it can also be used for comparative noise level tests of the simpler type. Owing to the limitations of the existing layout, however, plans are being prepared for an improved chamber. The intention is that this should have an operating temperature range of from −50 to +160 deg F, and that it should be possible also to simulate altitudes of up to about 8,000 ft, the highest likely to be encountered in service by a fighting vehicle.

Trials and development services division

After a prototype fighting vehicle has been built, or modifications have been prepared for an existing one, the necessary testing work is carried out by the trials and development services division. This division is subdivided into a development trials group, military and development services sections, and the workshops already described. The trials group is further split into three wings, which deal respectively with tracked vehicles, wheeled vehicles and armament. Of these three wings, the first two are situated at Chobham, but the third, an almost entirely self-contained unit, is in Scotland. No other reference will be made here to the armament wing, because its work is outside the scope of this journal.

For convenience in organization and the allocation of personnel, the tracked and wheeled vehicle wings each comprise two sections. In the case of the tracked or A vehicles, one section deals with tanks, and the other with carriers and flotation equipment. The B vehicle wing, on the other hand, consists of light and heavy sections, the line between them being drawn—though not rigidly—at a vehicle weight of 10 tons. Whereas there is a constant turnover of light wheeled vehicles, the other sections have a more stable complement of vehicles, except when new prototypes come in for test. The allocation covers all vehicles of the appropriate types that are currently in service, and they are modified or fitted with new equipment in accordance with the particular projects in hand.

There are three additional sections in the trials group: one is an electrical and instrument section, the second is a vehicle maintenance section, and the third is the plant squad. The first provides a common service to both vehicle wings, its main activity being the instrumentation of vehicles for the trials. All wheeled vehicles on trials are serviced by the maintenance section, which is also responsible for the administrative vehicles in the branch, but the tracked vehicles are serviced by their drivers. The plant squad is kept very

Layout of the test track that is adjacent to the Establishment, at Longcross, near Chobham

A *F.V.R.D.E. buildings;* **B** *Bailey bridge over public road;* **C** *marshalling area and track control tower;* **D** *outer circuit;* **E** *suspension courses;* **F** *test slopes;* **G** *slip pad;* **H** *wading pit, articulation gauges and ramps;* **J** *tilting platform;* **K** *winch test house;* **L** *snake mountain course*

fully employed on maintaining the existing cross-country tracks and, from time to time, on constructing new tracks and other test facilities that require the use of earth-moving equipment.

All trials records, including vehicle logs and details of modifications embodied, are maintained by the headquarters staff of the trials group. The staff officer responsible for these records is also in charge of the track controllers stationed at each of the three testing areas in regular use. Of the development services mentioned earlier, the most important are the drawing office, the photographic section and the technical library.

The three test tracks referred to in the last paragraph are situated at or near Chobham. Each area serves a different purpose. The first is used for speed and endurance running, and for tests of suspension, handling and other characteristics, details of which will be given later. At the second there is a series of four cross-country courses, grouped in an area of about one square mile, each of which has been carefully plotted to serve a particular purpose. They consist of a short circuit that is used for demonstration purposes, and rough road, heavy vehicle and alpine courses.

All wheeled vehicles and light tracked ones are run on these courses, whereas tanks, heavy tracked vehicles and, on occasion, heavy wheeled vehicles—such as gun tractors—operate at the third area, which is an Army training site and has no specific circuits. It is dusty in dry weather and provides plenty of relatively light mud after spells of rain. Other areas providing heavier mud are sometimes used, but no

Above left: A tank undergoing tests in the wading pit, the water depth of which can be increased to 16 ft for flotation trials. Left: For the investigation of fouling points and body tilt, articulation gauges are used; here, a six-wheel chassis is seen on a gauge of the compound type

entirely suitably dune region, for sand trials, is locally available.

On the accompanying plans is shown the layout of the first test area. It consists in essence of an outer circuit of approximately triangular shape, within which are the other facilities. To provide free access from the Establishment, and also to avoid damage to the public road by tracked vehicles, entry is only by way of a Bailey bridge over this road. This bridge has a load bearing capacity of 70 tons for tracked vehicles and 100 tons for wheeled vehicles. Since it also crosses the outer test circuit, vehicles entering or leaving the area do not interfere with trials in progress. For the bridge, a ramp leads into the marshalling area, on which is sited the track control tower.

On the outer circuit, the direction of running is changed at midday each day. The layout of the circuit is such that all service wheeled vehicles can sustain their maximum cruising speed on it. Adjacent to the control tower is the sharpest of the three corners, which is banked for 40 m.p.h. Then, travelling anti-clockwise round the circuit, comes the longest side of the triangle; this is not quite straight but incorporates two slight bends, one of each hand. The second corner, banked for 30 m.p.h, is less acute than the first and leads to a short straight followed by an obtuse-angle bend that is banked only sufficiently for the quick drainage of surface water.

On the final straight is a level, measured quarter-mile. Lap timing can be done, to a sufficient degree of accuracy, by means of a stop-watch in the control tower. The length of the circuit is just over 2 miles.

For obvious reasons, the outer circuit is virtually level, so what is called the snake mountain course has been provided to permit assessment of the hill climbing abilities on the road, the gear change and the handling characteristics on combined bends and gradients. This course leads over hilly terrain, from the middle of the first side of the triangle to that of the second side. Its length is about ¾ mile and it incorporates corners and gradients of varying serverities, some of them considerable.

Occupying a quarter-mile stretch parallel to the final straight are the three suspension courses—slatted, *pavé*, and boulder—the first and third of which are each divided into two sections. Both sections of the slatted course have the same layout, in that transverse ribs of concrete, about 4 in wide, are let into the tarmac surface. However, in one section of this course the slats are 1 in high, and in the other the height is 2 in. Each section has several rows of these ribs, the longitudinal pitching of which varies between one row and another. Thus, it is possible to check the behaviour of the suspension at different frequencies of impact, and to vary the frequency between one side of the vehicle and the other.

Though short in comparison with its equivalent at M.I.R.A., the *pavé* course is of equal severity, as can be gauged from one of the accompanying illustrations. The first section of the boulder course is just what its name suggests—an agglomeration of rough boulders of different shapes and sizes. It is not normally tackled by wheeled vehicles, for reasons that are only too apparent when it is inspected; re-laying is necessary at fairly frequent intervals because the weight of the tracked vehicles causes consolidation, and consequently reduced severity. In the second section of this course, the boulders are replaced by iron domes, about 4 in high, let into a concrete surface at a relatively wide spacing.

There are four concrete test slopes, all of the same height but of different gradients; their height is appreciably greater than that of the M.I.R.A. slopes. The gradients and angles of the four hills are as follows: 1 in 4, 14 deg; 1 in 3, 18½ deg; 1 in 2, 26½ deg; and 1 in 1·73, 30 deg. Wooden sleepers are let into the surface of the two steeper slopes, to provide adequate grip for the tracks of tanks. The slopes lead up to a large flat area, where vehicles can turn, at the far side of which are several anchorage points. When a vehicle is being tested on the steeper gradients, and there is a chance of its running back, it is connected to one of the anchorage points by a check cable.

Adjacent to the turning area is the large, circular slip pad, which is over 150 yards across. Situated at the edge of this pad is the tilting platform. The purpose of this platform, which is about 40 ft long, is to permit the maximum safe angle of static tilt to be determined for vehicles of all sizes. Normally, the lateral tilt only is required, but in certain instances the longitudinal figure may be needed. For this reason, the platform is wide enough for all save the largest types of fighting vehicles to be mounted transversely on it.

A good indication of the conditions in parts of the cross-country courses can be gained from this illustration. The loaded trailer has sunk nearly to wheel depth in the mud, and a heavy tank is being employed as a recovery vehicle. In this area there are numerous gradients, as well as some extremely rough surfaces

The platform is a steel, fabricated structure; as viewed in plan, it is of rectangular form, and its pivot axis is situated midway between the longer sides. At one side of the platform are eight hydraulic rams, grouped in fours. Because the pivot axis is below the centre of gravity of the platform assembly, tilting is self-energized once a slight, initial displacement has been imparted. To prevent twisting of the platform, the rams are hydraulically interconnected; their function, after initiating the tilt, is to control the angle of displacement, up to the maximum of 50 deg, and to return the platform to the horizontal position on completion of the test. Chock plates can be mounted at any desired points on the platform to prevent a vehicle from sliding sideways, and steel cables are used to restrain it as soon as overturning begins.

Near the tilting platform are the wading pit and a variety of articulation and other gauges. The wading pit is big enough to be used also for flotation tests, and it has a maximum water depth of no less than 16 ft. Water drains in under gravity from an adjoining storage tank, and is pumped back to the tank when not required. The entry and exit ramps of the pit are very steep, to simulate severe conditions of operation, and are slatted to provide track grip.

For the benefit of those who are unfamiliar with articulation gauges, such a gauge consists essentially of a flat-top ramp and a pit. One front wheel of the vehicle is placed on the ramp and the opposite rear wheel in the pit. Fouling points on the vehicle can then be investigated, and measurements made of the degree of body tilt in relation to suspension movement. If desired, the ramp can be used without the pit, or vice versa.

In addition to gauges of this type—known as simple articulation gauges—there are compound gauges for six-wheelers. These have two sets of ramps and pits for the rear wheels, but one set is reversed in relation to the other. Consequently, if the leading rear wheel on one side is on a ramp, the trailing one on the same side is in a pit, and the converse applies to the wheels on the other side.

Other gauges are used for determining belly clearance. Each of these consists of a double ramp, forming a shallow inverted V with an equal gradient on each side. To enable the clearance of various types of vehicle to be investigated, there are three belly gauges, differing in respect of the slope of the ramps.

The remaining facility comprises three loading gauges, the function of which is to permit assessment of the suitability of vehicles for transportation by air or water. Each gauge consists of a concrete ramp leading to a level surface and surmounted by a steel scaffolding structure. The gradient and height of each ramp corresponds to that used, in the worst conditions, with the appropriate type of aircraft or landing craft, and the superstructure simulates the opening through which the vehicle must pass. In the case of the two landing craft gauges, there is a bed of shingle at the bottom, which reproduces the conditions of loading and unloading that would occur on a beach. *Concluded*

New Alloy Steel

ACCORDING to The International Nickel Co. (Mond) Ltd, Thames House, Millbank, London, S.W.1, a useful new nickel alloy steel has been developed and patented by the company's U.S.A. associate, The International Nickel Co. Inc. In addition to its 18 per cent nickel content, this new steel contains 5 per cent molybdenum, 7 per cent cobalt and less than 0·5 per cent titanium; its maximum carbon content is 0·05 per cent. The yield strength of the material is stated to exceed 111 tons/in^2 and the temperature for zero ductility is below −80 deg F. Moreover, the notched tensile strength, measured in the most severe conditions with a notch radius of 0·0005 in, is unusually high, at 178 tons/in^2.

The combination of high strength, ductility and toughness is developed by means of a simple heat treatment involving the age-hardening of martensite, a process that has therefore been called Mar-ageing. After leaving the mill at the appropriate temperature, the steel is air cooled to room temperature; it is then heated to 900 deg F, which is held for three hours, and is again air cooled. Prior to the heat treatment just mentioned, solution annealing at 1,500 deg F is optional, but subsequent quenching is unnecessary.

It is stated that the steel can be readily welded by either manual or automatic techniques, and pre-heating is not required. After welding, the softened area is restored to full strength by a second Mar-ageing treatment, which also serves to induce properties in the weld metal that closely approach those of the base material. It is expected that, by varying the composition of the steel, tensile strengths as high as 220 tons/in^2 or more will be obtainable.

Development in Control Cables

A MINOR disadvantage of the orthodox Bowden type of control cable is, of course, that adequate lubrication is necessary in many applications if efficient operation is to be ensured. Because of the tendency of oil or grease to dry out when subjected to under-bonnet temperatures, engine control cables of motor vehicles tend to become jerky in action if not lubricated frequently. On this account, linkage systems are, in general, more favoured than cables for throttle controls, in spite of the problems imposed by the flexible mounting of power units.

To ensure a smooth, low-friction action in relatively high temperatures, without the necessity of lubrication, Teleflex Products Ltd, of Basildon, Essex, have developed a new type of control cable assembly incorporating a plastics sheath. The inner wire runs directly within this sheath, which is an extruded tube of Rigidex high-density polythene; Rigidex is a trade name of British Resin Products Ltd, a leading manufacturer of this material. To reinforce the sheath, spiral windings of wire and rayon are employed, and the covering of the outer casing is p.v.c.

Owing to the smooth bore of the polythene tube, and the low coefficient of friction of this material on steel, the efficiency of the control is high, even if the loading is considerable and loops or bends are embodied. In addition, high-density polythene is stated to be impervious to moisture and resistant to oil and wear. Teleflex Products have adopted the name Flexatrol for this assembly, which can be supplied in any desired length and with a variety of end fittings, to suit the requirements of any particular application.

Special Number

The Show Review number of *Automobile Engineer* will be published on Monday, the 27th November. It will constitute a critical review of the interesting new exhibits and will have numerous illustrations of special features and design characteristics. This special issue can be obtained, by order from newsagents throughout the United Kingdom, price 3s 6d net. Readers are reminded that it is necessary to order early from a newsagent to secure a copy.

Hydrostatic Transmissions

Extensive Range of German Units to be Manufactured in Great Britain by The Plessey Co. Ltd.

The complete Hydro-Stabil axle unit, intended for fork-lift trucks and factory vehicles, is very compact. It consists of a variable-displacement hydraulic pump and two motors of fixed displacement

AN agreement has been concluded for The Plessey Co. Ltd., to manufacture and market hydrostatic transmissions under licence from Guldner Motoren Werke, Germany. These transmissions, which are designated Hydro-Stabil, will be built in a 50,000 ft² factory acquired by Plessey at Cheney Manor, Swindon. Since the factory will not be in full operation for about two years, however, the interim demand will be met first by the import of complete units from Germany, and subsequently by the assembly at Swindon of German-made components.

Hydro-Stabil transmissions have been in production for the past five years and have been successfully applied to a variety of machinery, including mechanical handling equipment and factory vehicles. Because two important features of the Guldner system are positive control and an infinitely variable, stepless drive, many other possible uses are envisaged, such as in mobile cranes, tractors, machine tools and rolling mills.

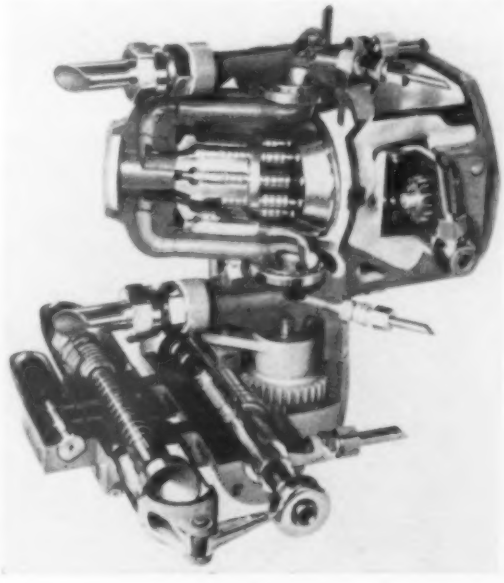
There are ten sizes of Hydro-Stabil pump and motor, ranging from 3 to 120 h.p, and both fixed- and variable displacement versions are available. In each case, the basic Toma principle is followed: the axial cylinders are disposed in a ring, and the pistons are connected to a plate that is integral with and normal to a shaft; since the cylinder block and the pistons thus rotate in unison with the shaft, the slipper pads of the swashplate arrangement are replaced by ball joints. The capacity of the unit is governed by the angular displacement of the axis of the cylinder block from that of the shaft. In the case of a fixed-displacement pump or motor, this angle is 25 deg, whereas on a variable-displacement unit it can be varied from zero to that figure in either direction. To permit articulation, the housing of the cylinder block is mounted on trunnion bearings, which can be seen in one of the accompanying illustrations.

A complete transmission system normally consists, of course, of a pump and one or more motors. If a variable displacement is required, this is provided by the pump rather than the motors, and the variations of the pump capacity are effected either manually or by means of a servo actuator. If desired, a variable-displacement pump can be fitted with a pressure-sensitive servo positioner, to ensure constancy of the horse-power output, and hence the most efficient use of the prime mover. The servos are powered by one of two detachable gear type pumps, the second of which provides a pressure boost to the intake ports and maintains the necessary rate of oil circulation for lubrication and cooling. These pumps are mounted within the casing, to obviate external oilways.

For factory runabouts and fork-lift trucks, the Guldner company has developed a complete axle unit comprising a variable-displacement pump and two motors, one driving each wheel through a reduction gear. This unit has a maximum output of 22 h.p, a maximum torque of 2,380 lb-ft, and a maximum input speed of 2,200 r.p.m. The axle casing forms the reservoir for 5 gal of fluid. Control is by two pedals situated side by side: depression of one pedal from the neutral or no-displacement position causes the wheels to revolve in one direction, and reverse rotation results from depressing the other pedal; the degree of depression controls the speed ratio between the input shaft of the pump and the output shafts of the motors. The weight of the unit is 505 lb, inclusive of the fluid.

A demonstration given by The Plessey Co. in September revealed that this system, as applied to a factory runabout called the Hydrocar, conferred remarkable ease of control. The vehicle, which is designed to transport loads of two tons at speeds up to 20 m.p.h, could be inched up or down a 1 in 4 gradient or manoeuvred very smoothly in confined spaces. Its diesel engine is fitted with a variable-datum governor controlled by a lever on the steering column, so can be run at any desired speed while leaving the driver's hands free; this feature would be particularly advantageous in the case of a fork-lift truck. Because of the high starting torque available, it is stated that the Hydrocar is capable of towing a trailer weighing as much as 10 tons.

This view of a part-sectioned pump shows the trunnion bearings for the cylinder block housing and, below, the servo actuator and the positioner that ensures constancy of the power output



This is the hard-top version of the Pininfarina Ferrari 400 Super America model illustrated on the opposite page. Because of the very low bonnet line, the vent on top of the lid is unusually high

Continental Coachwork

Part 2

A Review of the Latest Trends and Some of the Noteworthy Features of This Year's Models

THE first part of this article appeared in our September issue. It began with a review of latest trends, and continued with sections outlining interesting features of models recently produced by the Continental coachbuilders. In this second part, there are some more comments on interesting details, and the products of the different manufacturers continue to be dealt with in alphabetical order.

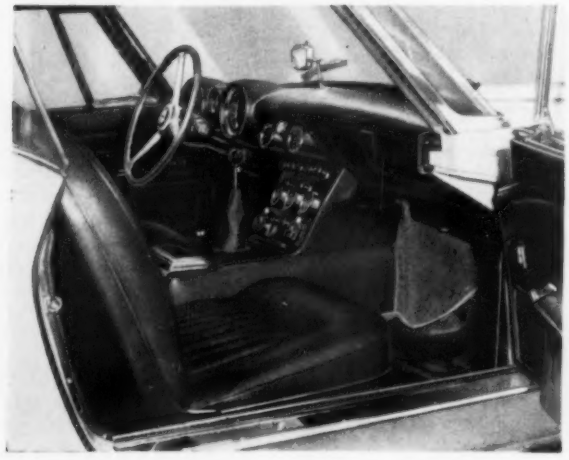
Pininfarina

As usual, Pininfarina this year have exhibited a relatively large selection of bodies. In the saloon car class, they include versions ranging from the Fiat 1200 to the Chevrolet Corvair. Among their sports cars are the 400 Ferrari Super America and Alfa Romeo Giulietta Spider. The Ferrari 400 Super America is a sports coupé. It is a design conceived with due regard to aerodynamic efficiency, and some indication of its performance potential can be derived from the fact that its engine develops 400 b.h.p. at 6,750 r.p.m.

A noteworthy feature of the front end arrangement is that there are no protrusions, except that of the bonnet vent. Perspex fairings are fitted over the headlamps, the lines of their lower edges on each side flowing into those of the tops of the wing openings. It is claimed that the slope of the front end causes the air stream to apply a downward force to help to ensure good road holding and steering. The radiator air intake opening is of lenticular shape and carries the traditional large-mesh grille. The flow of air through the engine compartment is facilitated by a scuttle vent on each side.

Slender lines characterize the roof, and the rearward raked windscreen pillars are unusual in that they are curved to follow the streamlined form of the glass. A channel section pressed in the side panels of the body forms a horizontal line extending from the front wheel opening, over

A simple console assembly is fitted beneath the facia of the Pininfarina Ferrari hard top vehicle. Above it, are two rotary valves for controlling the direction of flow of the air for the interior heating and ventilation



The door trim arrangement of the Pininfarina Ferrari Super America. A clean layout has been obtained by virtue of the facts that the window is electrically actuated and the door handle is in line with the armrest

the top of the rear wheel opening, to the wrap round portion of the rear bumper. This line gives an illusion of length and divides the side of the vehicle harmoniously into two equal portions below the waistline. The door handle is a pull-up lever in a deep recess.

A noteworthy feature of the rear end is the simplicity of its styling. This is achieved by housing the rear and stop lamps in apertures in the two-piece rear bumper, where they harmonize with the two pairs of exhaust tail pipes, one on each side, below them. Number plate illumination lamps are housed in the open inner ends of the two pieces of the bumper. In the centre, a reversing lamp is mounted below the level of the bumper, and it is of rectangular form, to harmonize with the boot lid handle above it.

Another version of this vehicle is the convertible model, with a detachable hard top. This, like the fixed-head coupé, has a very low radiator air intake opening but is a more practical general purpose vehicle, having conventionally mounted headlamps on the wings and auxiliary lamps on the grille. Scoops behind the radiator grille direct air on to the brake drums. There are rubber inserts in the leading edges of the bumper overriders.

On the bonnet lid there is an unusually high vent, to clear the carburettors. Its front end stands 2¼ in proud of the surrounding panel, and its edge is fitted with a chromium plated garnish strip. Inside the opening, there is a large-mesh, rectangular grille to match that in the radiator air intake. A feature that is unusual now among European cars is the humped wing crowns at the front and rear. Horizontal flow is maintained, however, by a pressed line in the side panelling: it is skilfully positioned, extending from a point slightly less than 1 in above the front wheel opening to scarcely ½ in above the rear one. From the illustration it can be seen that the direction indicators are placed so as to continue this line forward to the centre of the headlamp. The leading edge of the rear quarter light is of unusual shape, but it harmonizes with the curves of the waistline and of those that define the edges of the door-shut pillar.

At the rear of the vehicle, the back light has only a very shallow camber. The panel surround continues the profile out to a marked line where it joins the rear quarters. Above, the roof is overhung, and there are air extraction vents below the overhung portion. This roof and rear light assembly is removable. It is secured by three toggle clips on the windscreen headrail and two hook-like retainers on the lower rail of the rear light, together with a spigot for the location of the quarter light at the top of each door shut pillar.

A neat group of three lamps is housed vertically in the trailing end of the rear wing. Horizontal features are accentuated by two pressed lines across the rear panels: one forms a sill at the lower edge of the boot opening, and the other is above the number plate mounting, which is on the boot lid. Below, an eye is formed in each overrider on the bumper, and through it project twin exhaust pipes. Above the eye on each side, but mounted on the skirt panel, is a reflector. The construction of the bumper is unusual in that it comprises three pieces, the two junctions being concealed by the overriders. There are attachment points to the chassis and body at each end of the centre portion and also at the ends of the side pieces.

By virtue of the rear engine layout of the Chevrolet Corvair, an unusual approach to the styling of an American car has been adopted for the body by Pininfarina. The bonnet is carried down to a very low level, and its lid is hinged on the bumper overriders! As is common practice in America, the bumper is flush with the skirt panel. An

On the right is illustrated the streamlined, Super America sports coupé version of the Pininfarina Ferrari 400, and below is a view of the rear end of the vehicle. Unusual features of the layout at the rear are the recessing of the rear lamps in the small overriders, and of the number plate illumination lamps within the inner ends of the two-piece bumper assembly

Twin exhaust tail-pipes project from the small overriders at the rear of the hard-top version built on the Pininfarina Ferrari 400 chassis

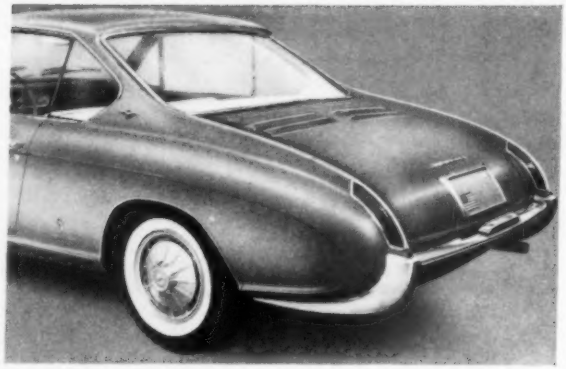
Left: Because of the rear engine layout, this Pininfarina Chevrolet Corvair has a very low bonnet profile, and the lid is hinged on the two overriders on the bumper

Below: Rear end of the Pininfarina Corvair, showing the harmony of line on the rear quarter panels

accompanying illustration shows the elegant door handles, well chosen to match the overall styling conception.

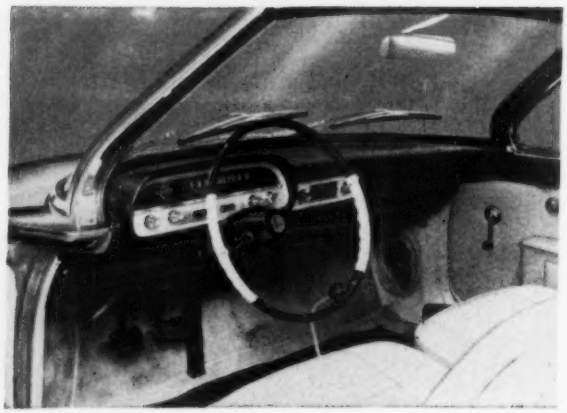
At the rear of the vehicle, the bumper overriders are little more than chromium plated overlays on the body panels. The bumper section between them is also laid on the panels. Large vents, for engine cooling, are pierced near the upper edge of the bonnet lid. On each side, the rear wing crowns, the rear lamp assembly and the swept under overriders are virtually a continuous line in the form of a semi-ellipse, on the minor axis, and this line is echoed by a similar one pressed in the side of the rear quarter panelling, as can be seen from the illustration on the right.

As in most of the Pininfarina models, a sheet of foamed plastics is laid beneath the carpet, and a rubber mat is attached on top, in the areas most subject to wear. The



Left: An unusual form of door handle, with an elongated press-in centre portion, is employed on the Pininfarina Chevrolet Corvair model

Below, left: A very large vent for the air-conditioning system is incorporated in each dash side panel of the Pininfarina Chevrolet



accompanying illustration shows the simplicity of the dash facia layout. There is an unusually large vent in each dash side panel, which directs air, either warm or cool, into the interior.

On the Pininfarina Flaminia models, a new feature is the neat air conditioning unit shown in an accompanying illustration. This unit is an optional extra and is supplied by Ipra, of Via Spalato 68, Torino. The compressor employed is the Tecumseh HA850. It is used in conjunction with a condenser, fitted in front of the radiator, and an evaporator in a box mounted beneath the dash facia. On the face of the box are two control knobs, one for the air supply and the other for the temperature, and three large, adjustable rotary louvre assemblies for regulating the direction of the stream of outgoing air.

Touring

The Touring Superloggera Berlinetta Praho is based on the Alfa Romeo 2000 chassis. It is of interest because it is another example of styling to accommodate the four headlamp arrangement. The lamps are mounted horizontally side by side in the forward ends of the wings. To avoid undue width locally, the wing panels are wrapped closely around each side. Another device to reduce the width of the wing crowns is the formation of a line along the centre, by dropping the panel sharply to the level of the bonnet surround. This line extends forwards from the windscreen pillar to a point about 7½ in from the headlamps, where it is swept inwards and then forwards again just inboard of the inner lamp. The depth of the drop from the crown line is

By virtue of the concave rear light on the Touring Superloggera Berlinetta Praho, the boot lid can be opened wider than would be possible with a conventional convex glass and rear quarter and canopy

The four headlamps and modified Alfa Romeo grille layout of the Touring Berlinetta Praho conforms with modern conceptions

The two illustrations at the foot of this column are of the Ipra air-conditioning unit, as installed in the Pininfarina Flaminia models. One is of the evaporator box, which is mounted beneath the dash facia, and the other is a diagrammatic layout of the entire installation in the car

about 1½ in at the point where it sweeps inwards, and it tapers to zero at the windscreen pillar. There is also a line pressed along the spine of the bonnet lid, as can be seen from the illustration above.

The horizontal layout of the lamps harmonizes well with the elongated rectangular forms of the side leaves of the Alfa Romeo trefoil grille. At the outer extremity of each of these leaves there is a circular, direction indicator lamp mounted on a rectangular chromium plated bezel assembly. The forward portion of the bonnet surround panel is turned sharply downward to form another horizontal line at the level of the top rail of the central leaf of the trefoil.

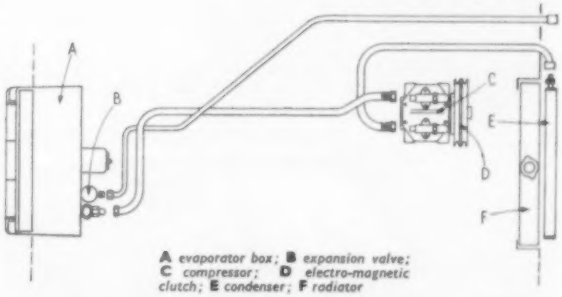
At the rear of this vehicle, there is a large concave back light, which is approximately 20½ in deep. The only advantage of this arrangement would appear to be that it enables the boot lid to be opened wider than would otherwise be possible. All the pillars above the waistrail are slender, the screen pillars, including the frame of the ventilator panel, are 2⅞ in wide; without this frame, the width is only 2 in. The rear pillars are 3⅛ in wide, as viewed in side elevation. Because of the concave form of the glass, however, the rear parcels shelf has had to be deeply dished, for clearance.

Vignale

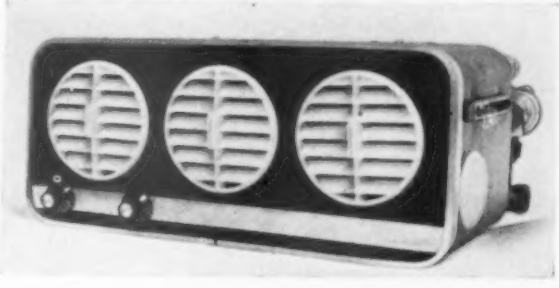
For several years, Vignale have tended to use contrasting colours to accentuate horizontal lines, instead of relying entirely on chromium plated strips or pressed lines in the body panelling. This year's example is the Vignale En Plein body on the Fiat 2100 chassis. The contrasting colours are metallic bronze and black, the black being used for a band, extending from front to rear, along the side of the vehicle, and also on the roof.

At the front, there is a rectangular, forward projecting air intake for the radiator. The grille itself is a chromium plated perforated pressing. It has rectangular perforations, with the vertical strips between them pressed to form rectangular section channels.

The bumper is of large section, and overriders are fitted on it each side of the projecting radiator opening. Two auxiliary lamps are mounted underneath the bumper, just inboard of the overriders. An unusual feature is the mounting of the headlamps and direction indicator lamps beneath a hood of complex shape, which can be seen in the illustration. This, and the relatively large section of the



A *evaporator box;* **B** *expansion valve;* **C** *compressor;* **D** *electro-magnetic clutch;* **E** *condenser;* **F** *radiator*



NEW BRITISH CARS

Summary of the Noteworthy Features of Recently Introduced Vehicles

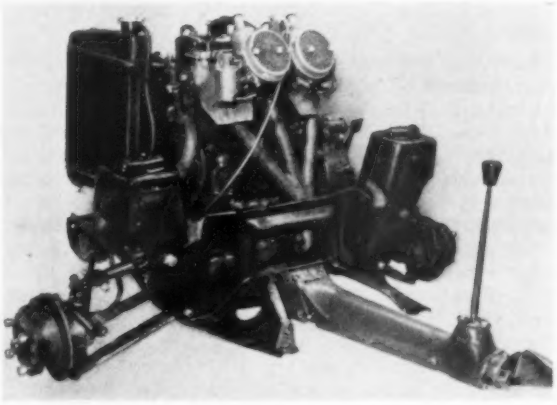
B.M.C. ADO 50

IN the two years since the British Motor Corporation introduced its ADO 15 cars, these remarkable little vehicles have become highly regarded for the excellence of their road-holding and cornering. Because of these qualities, a considerable demand has grown for versions providing even better acceleration and higher maximum speed. This demand has been met hitherto by the various companies specializing in increasing the output of standard engines. Now, however, B.M.C. has started production of an additional, high-performance range bearing the designation ADO 50 and known as the Austin Seven Cooper and Morris Mini-Cooper.

These names give public recognition of the co-operation of Cooper Cars Ltd. in the development of the new models, the engines of which are basically similar to those installed in the 1961 Cooper Formula Junior racing cars, and which embody much of the experience gained in racing. Since the racing engines operate satisfactorily in an even more highly tuned form than do the road-going versions, it is clear that the marked superiority of performance of the ADO 50 over the ADO 15 should not be accompanied by any risk of basic mechanical unreliability. In fact, the normal twelve-month guarantee applies.

The increased power and torque of the ADO 50 engine have been obtained by enlarging the swept volume from 848 cm^3 to 997 cm^3, raising the compression ratio and improving the breathing. As would be expected, the overall top gear ratio has been raised, and the gearbox ratios are closer. To ensure that the braking matches the high performance, disc brakes are fitted to the front wheels. Various improvements have been made to the interior trim, seating, instrumentation and sound proofing, thus making the car more luxurious. The result of these modifications is a vehicle that should be eminently suitable for maintaining high average speeds in comfort.

Because so much of the specification is the same as that of the ADO 15, this description and the accompanying data table are abbreviated to cover only the major differences. The earlier car was, of course, described in detail in the April, May and June 1961 issues of *Automobile Engineer*, and the complete data table was published in our New British Cars feature in August 1959.

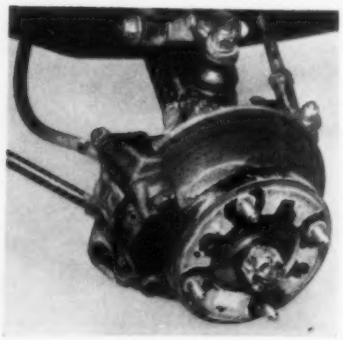


The two-carburettor power unit has a swept volume of 997 cm^3, as against the 848 cm^3 of the ADO 15, and develops 55 b.h.p; a torsional vibration damper is fitted to the crankshaft. Closer gear ratios have been adopted, as has a gear lever of the remote control type

To obtain the increase of 17½ per cent in the swept volume, a crankshaft of 81·28 mm stroke—as against the 68·26 mm of the ADO 15 engine—is employed, but the bore has been slightly reduced, from 62·9 mm to 62·43 mm. Consequently, the larger unit has a stroke : bore ratio of just over 1·3 : 1, which is relatively high by today's standards. The new crankshaft has thicker webs, and the diameter of the overhung portion carrying the clutch has been increased. Owing to the wide speed range of the engine, a torsional vibration damper is mounted on the nose of the crankshaft. At the peak speed of 6,000 r.p.m, the mean piston speed is 3,230 ft/min, whereas the corresponding figure for the 848 cm^3 engine—which has a peak speed of 5,500 r.p.m.—is 2,460 ft/min.

A cylinder head assembly similar to that of the Austin-Healey Sprite Mark 2 and the new M.G. Midget is employed. Its inlet ports and valves are larger than those of the ADO 15 head, and double valve springs are fitted. In addition, it has better gas flow characteristics, by virtue of modifications to the combustion chamber shape. The camshaft gives a higher lift and greater overlap than the standard shaft. Although the compression ratio is 9 : 1, the manufacturers state that the engine runs satisfactorily with normal premium petrols. Improved induction at high r.p.m. is obtained by the use of two S.U. carburettors, with individual air filters, mounted on an aluminium inlet manifold; restriction in the exhaust system is minimized by the use of a three-branch layout devoid of sharp bends.

The gross power output quoted in the table is, of course, almost exactly 55 b.h.p/litre; it can be otherwise expressed as 2·89 b.h.p/in^2 of piston area and represents power : weight ratios of 0·175 b.h.p/lb of the engine-transmission unit, and 89·3 b.h.p/ton of the vehicle kerb weight. Maximum torque occurs at 3,600 r.p.m, but the curve is unusually flat, as is



Lockheed disc brakes of 7 in diameter have been adopted for the front wheels; the rear drum type brakes are identical with those of the ADO 15 models

evidenced by the figure of 50 lb-ft at 1,000 r.p.m.—a drop of only 8 per cent. The ratio of maximum torque : torque at maximum b.h.p. is 1·13 : 1, and that of the speeds at maximum torque and maximum b.h.p. is 0·6 : 1. For the 17½ per cent increase in the swept volume, the power output has been raised by 48·6 per cent and the torque by 23·8 per cent, which must be regarded as highly creditable.

Although the layout of the transmission system is unaltered, three major changes have been made: a 1·03 : 1 reduction replaces the 1 : 1 gearing between the clutch output shaft and the gearbox—thereby raising the overall top gear ratio from 3·76 : 1 to 3·65 : 1—and the increased torque has permitted the use of considerably closer gear ratios. The already relatively high third gear ratio has been raised by 4 per cent, but second, first and reverse are all approximately 13 per cent higher. In addition, gear changing has been made more convenient by the adoption of a remote control mechanism, in place of the relatively long and inclined lever of the ADO 15. The linkage is enclosed in a cast aluminium extension bolted to the rear of the final-drive casing, and the short gear lever is positioned vertically, almost immediately below the rim of the steering wheel, and so is satisfactorily close to the driver's hand.

At the rear, the brakes are the Lockheed 7 in diameter × 1½ in wide drum assemblies employed on all four wheels of the ADO 15. Lockheed 7 in diameter disc brakes of orthodox but commendably compact design are fitted to the front wheels, as a result of which the total swept area has risen by 43 per cent, and is equivalent to 256 in²/ton of the kerb weight. A modification has been made to the pressure-limiting valve in the rear brake circuit, to suit it to the altered characteristics of the new system, and a Lockheed intensifier is embodied to raise the line pressure in the front brake circuit.

Felt linings are applied to most of the body panels, including the floor, roof and doors, and considerable care has been taken over the insulation of the engine compartment: the front face of the dash has a quilted covering, and thick insulating panels are stuck to the underside of the bonnet lid. Some of the damping material, the improved trim and the more comprehensive instrumentation are featured on the ADO 15 Super models that were announced by B.M.C. concurrently with the two ADO 50 cars.

SPECIFICATION DATA

Engine

Number of cylinders 4
Bore 62·43 mm
Stroke 81·28 mm
Swept volume 997 cm³
Compression ratio 9 : 1
Maximum b.h.p. (gross) 55 at 6,000 r.p.m.
Maximum b.m.e.p. 135 lb/in² at 3,600 r.p.m.
Maximum torque 54·5 lb-ft at 3,600 r.p.m.
Carburettors Two S.U. HS2, semi-downdraught, with 1¼ in throttle barrels
Dry weight Approximately 315 lb, with fan, radiator, clutch, gearbox, final drive and electrical equipment

Transmission

Gearbox Housed in engine sump and driven from clutch output shaft by helical gears providing 1·03 : 1 reduction. Four forward ratios, with synchromesh on second, third and fourth

Gear ratios

fourth	1 : 1
third	1·355 : 1
second	1·916 : 1
first	3·20 : 1
reverse	3·20 : 1

Brakes

Front Lockheed hydraulic, disc type, with pressure intensifier. Disc diameter 7 in; total swept area, 102·4 in²

Rear Lockheed hydraulic, drum type, with pressure-limiting valve and cable actuation by handbrake. Drum diameter, 7 in; shoe width, 1¼ in; total swept area, 55 in²

Dimensions

As for ADO 15 except for the following:

Kerb weight 1,380 lb

Weight distribution

front	63 per cent
rear	37 per cent

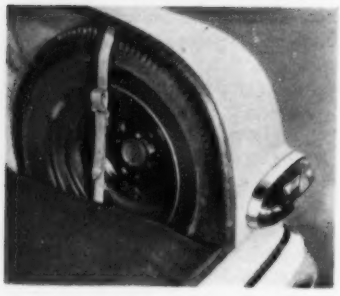
VAUXHALL VICTOR

ALTHOUGH Vauxhall Motors' latest 1½ litre car is still designated Victor, it differs so considerably from the earlier series of the same name that it can be regarded as a completely new model. Not only has the body styling been radically changed, in favour of clean lines, but the accommodation for passengers and luggage has been increased, the structural layout improved and greater attention paid to durability of finish and protection against corrosion. The engine output is slightly greater than before, and a four-speed, all-synchromesh gearbox has been developed as an optional extra. Another important advance is that the number of grease nipples on the chassis has been reduced to four, which require attention only at intervals of 12,000 miles. Three saloon versions and an estate car are offered.

The new car is 5½ in longer and ½ in wider than its predecessor, and its wheelbase is 2 in greater; in addition, the front and rear tracks are increased by ⅝ in and 1 in respectively. However, the overall height has been reduced by as much as 2½ in, the centre of gravity lowered by 1½ in and the frontal area decreased by 1 ft². Since all the accommodational dimensions—including the important one of leg room for the occupants of the rear seat—have been increased by worthwhile amounts, it is highly creditable that the kerb weight has actually been reduced by 70 to 95 lb, according to the model. The ratios of wheelbase : overall length, wheelbase : mean track, and mean track : overall width are respectively 0·578 : 1, 1·96 : 1 and 0·795 : 1.

In redesigning the unitary structure, the Vauxhall

In appearance, the new Victor bears no resemblance to its predecessors; the lines are clean, and external decoration has been kept to a minimum. There is a marked increase in the glass area, and the windscreen wipers now operate in a parallel sense. In spite of its increased size, the Victor is lighter than before



Owing to the mounting of the spare wheel in the space behind the right-hand wheel arch, the boot has the very large capacity of 21·4 ft³. A 10 gal petrol tank is now specified

engineers have concentrated on two objectives—achieving the lowest possible ratios of weight to strength and rigidity, and minimizing the risk of corrosion. Among the means adopted of saving weight is the replacement of the previous bolted-on front cross member by an integral structure that carries the suspension and the front of the engine. Box-section extensions ahead of this structure increase the resistance to frontal impact.

Underneath the car, every effort has been made to obviate the trapping of mud and water. Sharp corners, pockets, undercuts and shelves have been avoided wherever possible, and narrow flutes in the floor panels have been replaced by large but shallow depressions of elliptical shape. An additional means of resisting corrosion is an increase in the depth of the initial dip in black primer; the entire body below the roof panel is now immersed in a 5,000 gallon tank. Subsequently, polythene wax with an aluminium filler is sprayed into the sills, to protect their interior surfaces. It is worthy of mention that the coating of the underside of the body and wings with a bituminous compound was introduced by the company in 1957; this treatment is now applied over a second, red priming coat, which is sprayed on. For the final painting of the bodies, a cellulose-base synthetic enamel has been adopted, for which an unusually good combination of surface hardness and retention of lustre is claimed.

In the new bodies, seating comfort has been improved and the glass area increased. The windscreen pillars now have a normal rake which, in conjunction with the wider doors, facilitates entering and leaving the car. A change from opposed to parallel motion of the wipers has resulted in much enhanced forward vision in wet weather. The screen embodies the so-called safety zone, of slightly reduced toughness, detailed in B.S.857, and described in our September issue.

Several changes have been made to the 1,508 cm³ engine of the Victor, though the basic dimensions of the earlier units are retained. The compression ratio has been raised from 7·8:1 to 8·1:1, and the exhaust valves are now aluminized to increase their life. Weight has been reduced by the use of aluminium instead of iron for the induction manifold, timing gear case, water and oil pump bodies, clutch housing and gearbox rear extension.

In addition, the engine mounting layout has been modified so that 82 per cent instead of 37 per cent of the weight of the power unit is carried by the frontal structure of the vehicle. This revised arrangement not only reduces the bending stresses on the underframe members, but brings the front mountings closer to the centre of percussion of the engine, thereby providing enhanced smoothness of running. Other improvements involve the crankcase breathing and exhaust silencing.

Both the power output and the torque have been improved by the increase in compression ratio and by the better breathing of the new inlet manifold. In the case of the gross b.h.p, the increase amounts to 3 per cent, at 400 r.p.m. higher rotational speed; whereas the maximum torque is only a little over 1 per cent more, it is obtained 200 r.p.m. further down the speed range. The power output quoted in the table is equal to 37·3 b.h.p/litre, 1·84 b.h.p/in² of piston area, 0·171 b.h.p/lb of the engine dry weight and 60·7 b.h.p/ton of the kerb weight of the standard saloon. For the ratios of maximum torque : torque at maximum b.h.p. and of speed at maximum torque : speed at maximum b.h.p, the figures are 1·33:1 and 0·478:1 respectively.

Although the steering-column gear-change of the earlier Victors has been widely regarded as one of the best of its type, further improvements have been made to the linkage on the new series cars, for which the familiar three-speed gearbox remains standard. These changes are claimed to give still lighter, smoother and more precise action. The new four-speed gearbox has been developed from the three-speed version and, to rationalize production as far as possible, contains a number of common parts. It has baulk ring type synchromesh on all forward gears, and gear changing is effected by means of a short, floor mounted lever and a remote-control linkage. Vauxhall Motors Ltd. have stated that the car is the first British post-war saloon in the popular class to have synchromesh on the bottom gear of a four-speed unit; in the case of the three-speed gearbox, the feature was, of course, adopted about four years ago.

Torsional resonance in the drive line has been suppressed by enlarging the diameter of the propeller shaft from 2½ in to 3 in. The universal joints are of the sealed type, requiring no lubrication during the life of the shaft. In the final-drive assembly, the only change has been to raise the ratio by 6 per cent on the saloons and 12 per cent on the estate car,

SPECIFICATION DATA

Engine

Number of cylinders 4
Bore 79·4 mm
Stroke 76·2 mm
Swept volume 1,508 cm³
Compression ratio 8·1 : 1 (7·0 : 1 optional for export)
Maximum b.h.p. (gross) 56·3 at 4,600 r.p.m.
Maximum torque 85·6 lb-ft at 2,200 r.p.m.
Maximum b.m.e.p. 140 lb/in² at 2,200 r.p.m.
Crankshaft Three bearing, forged steel
Cylinder head Cast iron, with bath tub type combustion chambers and vertical, in-line valves, push rod operated
Carburettor Zenith 34 VN, with 25 mm diameter choke
Fuel pump AC mechanical
Dry weight 329 lb, including clutch

Transmission

Clutch Borg and Beck single-dry-plate, 7½ in diameter, with hydraulic actuation
Gearbox Choice of three-speed or four-speed, both with synchromesh on all forward ratios
Gear ratios

	Three-speed	Four-speed
fourth	—	1 : 1
third	1 : 1	1·355 : 1
second	1·635 : 1	2·130 : 1
first	3·186 : 1	3·29 : 1
reverse	3·05 : 1	3·05 : 1

Dry weight 59 lb, including bell housing
Propeller shaft Hardy Spicer open type, with needle roller bearing universal joints

Final drive

Type Semi-floating, with hypoid bevel reduction
Ratio Saloons, 3·9 : 1; estate car, 4·125 : 1

Suspension

Front Double transverse wishbone type, with coaxial coil springs and Vauxhall telescopic dampers, and anti-roll bar
Rear Semi-elliptic leaf springs, with Vauxhall telescopic dampers

Steering

Type Burman recirculating-ball
Ratio 13·5 : 1
Turns from lock to lock 3·8
Turning circle 36 ft

Brakes

Front Lockhead hydraulic with 8 in diameter composite drums having cast iron rims and pressed steel webs; twin leading shoes, 1½ in wide. Total swept area, 75·3 in²
Rear As at front, but leading and trailing shoes. Mechanical actuation by handbrake
Distribution of braking effort
front 65 per cent
rear 35 per cent

Wheels and tyres

Wheel type Pressed steel disc, with four-stud attachment and 4 in wide rims
Tyres Tubeless, 5·60–13 in 4-ply on saloons, 5·90–13 in 6-ply on estate car
Pressures, normally laden
front 24 lb/in²
rear 24 lb/in²

Dimensions

Wheelbase 8 ft 4 in
Front track 4 ft 2⅛ in
Rear track 4 ft 3 in
Overall length 14 ft 5½ in
Overall width 5 ft 4 in
Overall height, laden 4 ft 7½ in
Ground clearance, laden
saloons 6·3 in
estate car 7·0 in
Frontal area 19·1 ft²
Kerb weight, without fuel
standard saloon 2,080 lb
estate car 2,200 lb
Weight distribution Standard saloon: 54 per cent front; 46 per cent rear. Estate car, 51 per cent front; 49 per cent rear

which, in fact, now has the hypoid bevel assembly formerly fitted to the saloons. This higher gearing has been made possible by the lower weight and reduced drag of the vehicles, and the small increase in engine performance.

After investigating various forms of independent rear suspension, Vauxhall Motors decided that the live axle system represented the cheapest means of obtaining acceptable standards of riding comfort and handling. The semi-elliptic springs are wide and flat, and are mounted further apart at their front than their rear ends, to provide a slight increase in roll stiffness for a given rate. Stability is, of course, improved by the increase of track and the lower centre of gravity. To minimize the height of the propeller shaft tunnel, movement of the axle nose is controlled by snubbers. The spring rate of the rear suspension is 75 lb/in—90 lb/in is optional for export markets—and the periodicity, roll centre height and roll stiffness are 67 c/min, 11·2 in and 91·6 lb-ft/deg respectively.

In the front suspension, ball joints are now employed at both ends of the steering swivel members, whereas formerly the lower wishbones were attached by trunnion joints. The four grease nipples mentioned earlier serve for the lubrication of the ball joints of the swivel members. Rubber bushes replace the lubricated metal type at the inboard pivots of the wishbones, and rubber joints are also specified for the steering linkage. The spring rate, measured at the wheel, is again 75 lb/in, with the option of 90 lb/in; for the periodicity, roll centre height and roll stiffness, the figures are respectively 64 c/min, 0·75 in and 180 lb-ft/deg, inclusive of the anti-roll bar, which is of the orthodox type.

Production Engineering Research

OF undoubted interest to research workers and production engineers is the news that the International Institution for Production Engineering — otherwise known as C.I.R.P—is to compile a world register of production engineering research. This register, which will be multilingual, will provide full information about investigations carried out in research organizations, industrial companies, universities and colleges throughout the world.

It has been agreed that the extensive work of translating, editing, classifying and disseminating all the information to be incorporated in the register should be entrusted to the Production Engineering Research Association, of Melton Mowbray, Leics. The Association was chosen for this task because of its translation facilities and extensive communications with other organizations. A financial grant covering a two-year period will be made by the Organization for European Economic Co-operation.

The register will contain information on all production research carried out within the period 1959 to 1962 and will summarize plans for the following three years. Among its main subjects are assembly automation, finishing processes, inspection and measurement, machine tools and machinability, materials handling, and metal cutting and forming. All available data will be given regarding the establishments carrying out research programmes, and there will be references to publications and educational services.

To obtain the necessary information, a questionnaire is now being sent to all likely sources. All organizations carrying out any form of production engineering research are invited to write for a copy of the questionnaire to the Information Manager, PERA, at the address already given. In this way they will help to make this register as complete as possible, thus enhancing its value.

Closed-Circuit Television

IN INDUSTRY, increasing use is being made of closed-circuit television equipment. Among its functions, of course, are the monitoring of automatic production lines, and the investigation of vehicle suspension or transmission phenomena on the test track. A new set of this type has been introduced by Murphy Radio Ltd, of Welwyn Garden City, Herts, and is stated to be compact, simple and inexpensive. The camera unit, which has a glass-reinforced polyester resin casing, is 7½ in high by 4½ in wide by 10½ in deep, and weighs only 7 lb. It is designed to accommodate either a single lens or a four-lens turret.

The power unit has measurements of 7 in by 6 in by 5 in, and weighs 8 lb. Two standard types of monitor are available, having a 19 in and a 23 in screen respectively. An automatic sensitivity control circuit is incorporated, to enable a satisfactory image to be obtained, without adjustment of the controls, even if the brightness of the subject varies substantially, over a range of up to 50 : 1.

Toxic Atmospheres

A BOOKLET entitled *Toxic Substances in Factory Atmospheres* was published in April 1960, by the Ministry of Labour. In it, information is given on certain dusts and fumes likely to be injurious to health or to cause discomfort if a maximum permissible concentration is exceeded. Various methods of protection against the inhalation of dust and fumes are also described.

An amendment to this booklet has now been issued, in which the figures of maximum permissible concentration are brought up to date; an explanation is also given of the manner in which the figures should be interpreted. These figures, it is pointed out, are intended to be used as guides in the control of health hazards, and should not be regarded as lines of demarcation between safe and dangerous concentrations. Copies of this amendment are being sent to all those who, after purchasing the booklet, notified their desire to receive any such amendments.

Non-Destructive Testing

A ONE-DAY conference on "New Electronic Techniques in Non-Destructive Testing" is being organized by the West Midlands Section of the British Institution of Radio Engineers. It will be held on Wednesday, 6th December, at the Wolverhampton and Staffordshire College of Technology. Seven papers will be presented, and among the subjects to be covered are photoelectric and ultrasonic techniques. Further information and registration forms are obtainable from the Honorary Secretary of the Section, Major C. W. Weech, M.Brit.I.R.E, whose address is 5 Shelton Fields, The Mount, Shrewsbury.

BICERA Annual Report

COPIES are now available of the 18th annual report of the British Internal Combustion Engine Research Association; this report covers the year ending 31st March, 1961. Among the subjects on which research has been carried out during that period are turbocharging, fuel injection, stress analysis and vibration. The work of the stress analysis panel has included further investigation of the water-side attack of wet cylinder liners. Applications for copies of the report should be made to BICERA, Buckingham Avenue, Slough, Bucks.

Machine Tool Transporter

The Pitt L15, Ultra-Low Loader Semi-Trailer Incorporates Several Novel Features, Including Trailing-Link Independent Suspension

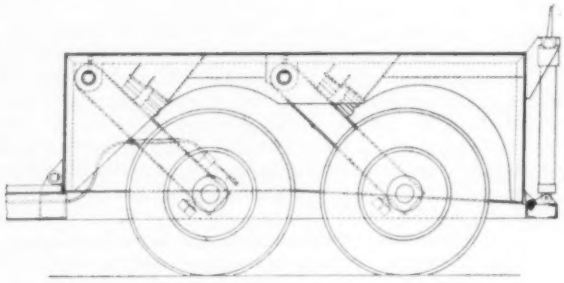
TO meet a demand for a vehicle for transporting battery-operated fork lift trucks that cannot be driven up normal ramps, Pitt Trailers Ltd, of Barton Stacey, Winchester, Hampshire, have produced a semi-trailer that is also eminently suitable for the transport of equipment such as machine tools. At the initial design stage, it was decided that the use of long ramps to obtain a suitably shallow incline would be impracticable because loading and unloading sites are not always large enough to accommodate them.

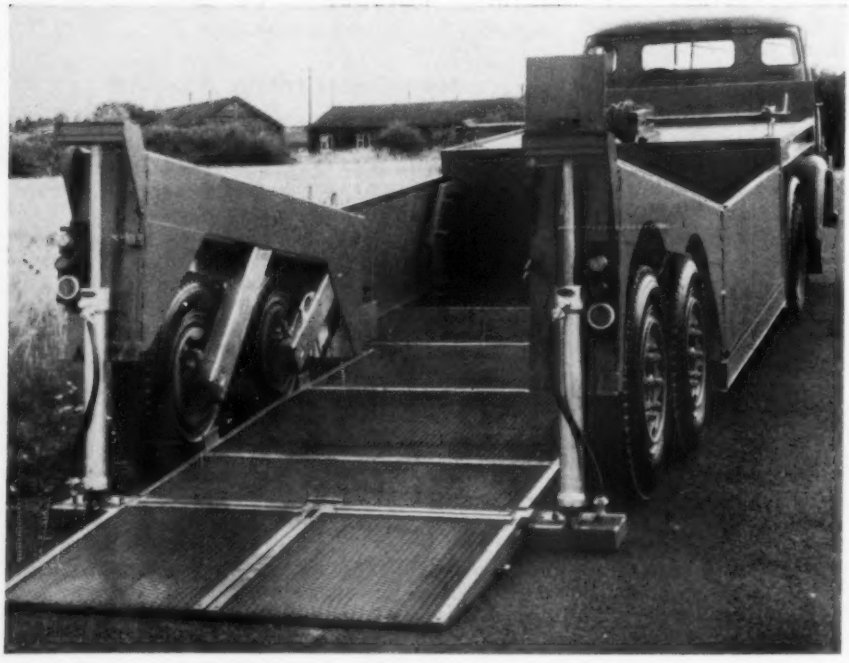
The outcome of the design study is the L15 semi-trailer. All four of its wheels are independently mounted on single trailing arms, and rubber in compression is used as the springing medium. For loading purposes, the rear end of the deck, pivoting about its front end, is lowered to the ground, and fork lift trucks or other machinery can be taken straight on without having to climb long ramps. The pairs of wheels of the semi-trailer are housed, in tandem, in hinged wheel boxes which, for lowering the deck, are swivelled hydraulically upwards about a transverse axis at their forward ends. During normal transport operation, the wheel boxes are secured to the deck structure.

When the deck has been lowered, the tail gate is dropped, to form with it a continuous surface with an inclination of approximately 1 in 10. Two fork lift trucks, each weighing 5 tons, can be carried on the semi-trailer, one in front of the other. By virtue of the adoption of independent wheel suspension, the deck space is adequate for the rear truck to be carried between the wheels of the semi-trailer.

After a loading operation has been completed, the deck is elevated to its riding height by two vertical single-acting hydraulic rams, each of which is mounted between a bracket at the top of the wheelbox and a lateral extension of the rearmost cross-member of the deck frame. When these extensions come into contact with the undersides of angle brackets mounted low down behind each wheelbox, they are secured there by four $\frac{3}{4}$ in bolts. Each of the trailing arms is at an angle of approximately 45 deg to the ground, and moves in a vertical plane parallel to the longitudinal axis of the trailer.

Four Aeon hollow rubber springs bear against the top face of each arm, and these are at a distance from the pivot axis such that the ratio of wheel deflection to effective spring deflection is approximately 3:1. These springs are mounted in pairs: those nearest the pivot are the type 103B, with a single convolution, and those nearest the wheel are type 540/70, with two convolutions. Small snubbers are on outrigger brackets on the side of the deck, to limit rebound





Above: Each wheel is mounted on a swinging arm sprung by four Aeon hollow rubber springs. The ratio of wheel deflection to spring deflection is 3 : 1

Left: The suspension arms are contained in wheelboxes which, when the rear of the deck is lowered, swing upwards about pivot pins at their forward ends, and do not impede the movement of the deck. After the cargo has been driven up the 1 in 10 incline of the sloping deck, two hydraulic rams lift this back to its normal ride height, and it is then secured to the wheelboxes by four bolts

movements of the arms. The total wheel movement is 5½ in.

At its widest part, the deck is 7 ft 6 in across, and it is 5 ft 3 in between the wheelboxes; the overall length is 18 ft. Mounted on the deck, immediately in front of the left-hand wheelbox, is a double acting hand pump for the hydraulic rams. With it, the deck can be raised in 1 min: this time is considered satisfactory, since the trailer is intended to be loaded only once a day. However, for applications involving more frequent use, a power-driven pump can be fitted to the prime mover, and then lifting the deck takes only 15 sec. In either case, the shut-off valve in the hydraulic system locks the rams hydraulically and thus assists the four bolts in securing the wheelboxes to the deck.

At the front, a 2 ton winch is mounted on top of the trailer neck. Rope can be taken up on the drum either directly at high level or, indirectly, over a roller set low in the neck. On the prototype trailer the decking is hardwood covered by expanded metal; this can, of course, be changed to suit customer's requirements.

Channel-section steel is used for the beams of the deck frame, and at mid span the central two of the four main longitudinal members are closed to form box sections. The wheelboxes are fabricated from 2 in × 2 in × ¼ in angle-section members, and ⅛ in and $\frac{7}{16}$ in plate, and the trailing arms are hollow units fabricated from ⅜ in plate. Each of the four wheels has a Lockheed hydraulic brake assembly, 16 in diameter by 3½ in wide, operated by a two-line air system.

Although the type of wheel suspension and springing adopted were chosen because of the peculiar loading and carrying demands of the trailer, other advantages were, of course, envisaged. It is claimed that, by virtue of the progressive-rate characteristics of rubber springs, an unusually good ride is obtained in the unladen condition, and braking efficiency is said to be of a high order as a result of both independent suspension and the large area swept by the friction linings. The manufacturers intend to market this vehicle as either a full trailer or a semi-trailer; a 5 ton version will have single wheels, and a 14 ton version will have 10.00 × 20 tyres instead of the 8.25 × 20 tyres of the 10 ton prototype. The 14 ton model will have an overall width of 8 ft, but the useful width between wheelboxes will be only 5 ft 1 in, because of the larger tyres.

New Plant and Tools

Recent Interesting Developments in Production Equipment

DIAL-TYPE thermometers do not normally have any external provision for re-setting the pointer to zero in the event of its falling out of adjustment. Now, however, the British Rototherm Co. Ltd, of Merton Abbey, London, S.W.19, have introduced a thermometer on the outside of which is a 2 BA Allen screw which, when slackened, allows the stem to be rotated relative to the casing. The movement thus afforded covers 50 per cent of the scale range. A countersunk instrument screw protects the Allen screw during normal operation of the thermometer.

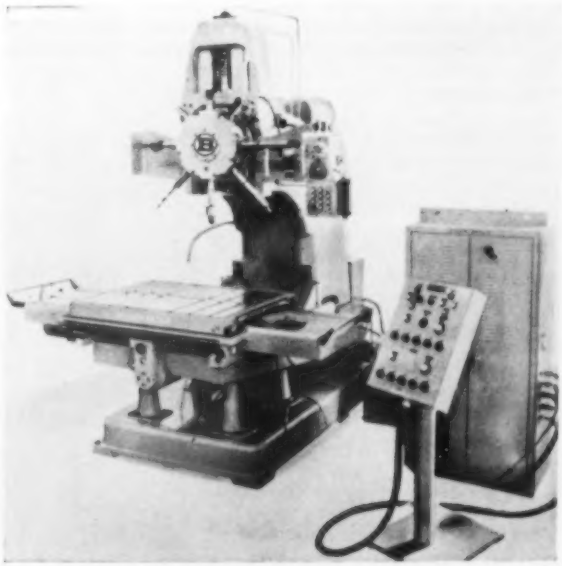
This thermometer is named the Zero Re-Set, and it was originally designed for use in countries where there is a high proportion of unskilled labour, and where adjustment or servicing of instruments of this type calls for expert attention, which is not always immediately available. With the object of reducing to a minimum the time lost in making adjustments, even in circumstances where skilled attention is readily available, the manufacturers are now offering the instrument on the home market. At present the thermometers are available with 2½ in, 4 in or 7 in dials, and they cover the standard temperature ranges. The dials are arranged for vertical mounting, but thermometers with dials for horizontal mounting will be in production shortly.

Side view of a dial-type thermometer. If the instrument loses its adjustment, the screw at the side of the dial, seen on the extreme left, is slackened, so that the dial can be rotated relative to the stem
(British Rototherm Co. Ltd.)

Tape-controlled turret drilling machines

As the result of an agreement between Kearney and Trecker-C.V.A. Ltd, Garantools House, Portland Road, Hove, Sussex, and the Burgmaster Corporation of Gardena, California, the full range of Burgmaster turret drilling machines is to be distributed in Great Britain. An interesting feature of this arrangement is that these machines can be equipped with punched-tape control equipment if desired.

Right: The Burgmaster type 3 BHT, one of a range of tape-controlled turret drilling machines using Ferranti co-ordinate positioning equipment
(Kearney and Trecker—C.V.A. Ltd.)



This is the Ferranti equipment, operating on the co-ordinate positioning principle: it is completely transistorized, and is powered by 12V batteries that are kept continuously charged from mains supplies.

The drill capacities of the Burgmaster machines range from ½ in. to 1½ in. There are four sizes of machine, affording a variety of speed and feed ranges, throat depths and table sizes. These machines are in three classifications: hand-operated, automatic hydraulic and numerically controlled; with regard to the last two, of course, the operator is required only to load and unload, and can supervise up to six machines at once.

In tape-controlled operations, the function of the control system is to position the table on two axes, select spindles in any sequence, and start the predetermined machining cycle for each spindle. The machines to which the control system is adapted are automatic hydraulically-operated ones that incorporate standard controls for pre-selecting spindle speeds, infinitely variable feeds, rapid approach and return, and positive depth control; however, the tape can be made to control drilling depth, spindle speed and the rate of spindle feed. In addition, the tape controls the clamping of the table in both axes, for locking it while machining operations are performed, and also auxiliary operations such as coolant flow, reciprocating feed for deep holes, and fume extraction. When each spindle completes its cycle, a microswitch on the drilling head is tripped, and the next turret position is selected; during the machining period, the tape is stepped forward ready for the next operation.

This control system embodies an error-checking device the functioning of which is based on ternary logic, and the drive is shut off if a counting error is noted: the checking involves the use of the Moiré fringe system. A very high degree of accuracy is claimed for the hole spacing on these automatic drilling machines: a figure of ±0·001 in is given for initial setting, and ±0·0005 in for repeated settings, with no guide bushes used. The model 3 BHT-B Burgmaster is the largest machine in the range, with 12 in turret travel and table movements of 48 in × 60 in. With model 2 BHT, the smallest, there is a choice of three table movements, the least of which is 10 in × 18 in.

Double-ended, taper turning lathe

Identical tapers on two mating conical components can be turned simultaneously by the Crossley-Beer double-ended taper turning lathe. This machine has a centrally mounted headstock that can swivel through 15 deg, and there are two independent co-axial spindles. On each side of the headstock there is a conventional carriage with a cross slide and tool post. On one of these tool posts there are boring tools, for both roughing and finishing operations, and on the other, turning tools.

Components intended for taper turning are held between centres, the tailstock for this purpose being fixed to the headstock by a cantilever beam which therefore takes up the same swivel angle. At the other side of the headstock, the components to be bored are held in a chuck. The two operations can be carried out simultaneously, or, if desired, alternately, in which case one component can be machined while the other is being unloaded and replaced; in this way, one operator is kept fully occupied. Automatic electrical sequence control is incorporated, and the order of operations can be preselected by means of contact plugs on the panel that is mounted between the two operating stations. For convenience, machining time on one side of the headstock can be made to correspond to clamping time on the other.

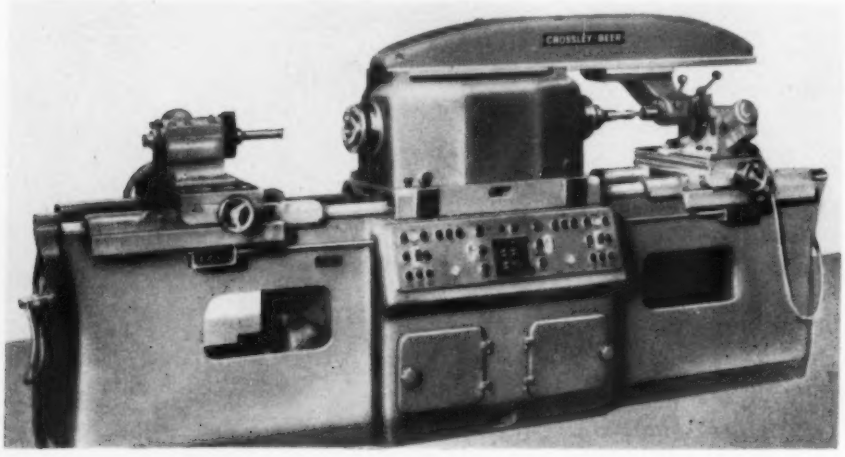
An area of floor 11 ft 2 in × 4 ft is required for this lathe, which is being distributed by Crossley Bros. Ltd, of Openshaw, Manchester, 11, and its working height is 41¼ in. The maximum swing is 12½ in, distance between centres 19¾ in, and the working stroke of the slide is 21 in. There are 18 spindle speeds, ranging from 235 to 3,000 r.p.m, and 13 feeds each for roughing and finishing.

Ball transfer tables

A range of standardized ball transfer tables is now being manufactured by Alwayse Castor Co. Ltd., of 79 Longmore Street, Birmingham, 12. Conveyor tracks that embody balls instead of rollers are, of course, widely used in systems

Each unit in this range of standardized ball transfer tables is 20 in square, but the size and spacing of the balls is selected according to the size, weight and shape of the load to be carried

(Alwayse Castor Co. Ltd.)



The headstock of this double-ended lathe can swivel through 15 deg, so that components turned at each end have similar tapers

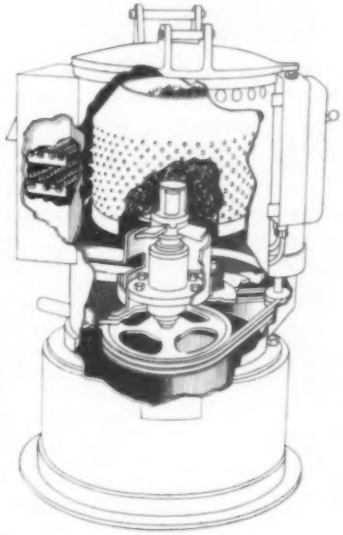
(Crossley Bros. Ltd.)

of mechanical or manual handling wherein sharp changes of direction are otherwise difficult to incorporate, or where simultaneous longitudinal and lateral movements are required. Each of these standardized tables is 20 in square, but there is a choice of the diameter and spacing of the balls, to meet a variety of requirements in respect of the weight, shape and size of the loads.

The tables are normally supplied with legs adjustable for height, but are also available as table tops only, for floor mounting or special applications. Around the edge of each table top is a row of holes for attaching roller equipment or for bolting a number of tables together, to form a long track or a surface of large area. Each unit has a normal maximum weight capacity of 5 cwt, but heavier loads can be accommodated on them if this should be necessary.

Separating oil and swarf

Considerable quantities of cutting oil, although suitable for immediate re-use, are lost through being removed with the swarf. Similarly, the tempering oils used in heat-treatment processes adhere to components, and become depleted quickly if no attempt is made to reclaim them. A centrifuge for recovering these adhering oils has recently been announced by R. Cruickshank Ltd, Camden Street, Birmingham 1. It embodies a heating element and fan for warming the oil and reducing the viscosity.



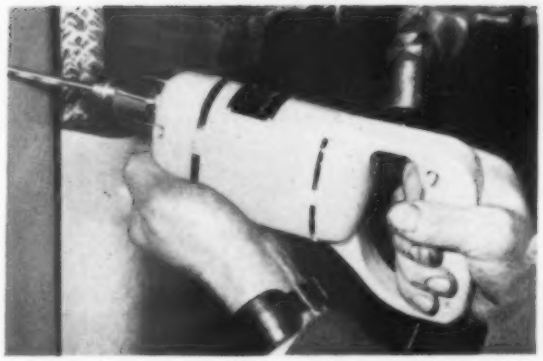
In this centrifuge, cutting oil and swarf, or tempering oil and small components, are separated, and the oil is reclaimed. To the left of the centrifuge basket is a heating element; hot air is circulated through the contents of the basket by the impeller beneath it, and the viscosity of the oil is thereby reduced. An annular tray around the impeller casing collects the oil, which flows out through the pipe projecting from the left of the machine

An external view of the centrifuge, of which a part-sectional illustration appears above; to the right is the motor that drives the basket and fan

(R. Cruickshank Ltd.)

The material from which oil is to be removed is loaded into a perforated steel basket which is placed in the centrifuge, and the shutting of the spring-loaded cover operates a microswitch to start the machine, which rotates at 420 r.p.m. Separation is completed in two to three minutes, during which time the oil passes through a filter into a container. An electro-magnetic brake stops the centrifuge as soon as its cover is lifted.

It is said that up to three gallons of oil per hour are reclaimed in this way from one machine; several machines can, of course, be in use simultaneously under the control of one operator. Among the advantages claimed for this centrifugal separator are a reduction in the amount of degreaser subsequently required for tempered components, and the obviation of dense smoke during the melting-down operations on light-alloy cuttings. This machine is named the Cruickshank 3C centrifuge; it is 3 ft 4 in high.



The model DRVC heavy-duty drilling machine. On top of the casing, between the name plate and the vent slot, is a small lamp to indicate that the machine is earthed and is correctly wired to the mains supply

(S. N. Bridges & Co. Ltd.)

Portable drill with overload cut-out

Among the new tools recently announced by S. N. Bridges & Co. Ltd, York Road, Battersea, London, S.W.11, is a portable drilling machine that incorporates an automatic overload cut-out device, for protection against mishandling. This machine, the model 77, has a drilling capacity of $\frac{1}{4}$ in diameter in steel, and operates at 2,350 r.p.m. at no load and 1,400 r.p.m. at full load. It is fitted with a Bridges Jacobs chuck taking a $\frac{1}{16}$ in diameter drill bit.

The cut-out is a thermally operated bi-metal unit embodied in the casing of the motor, and wired in series with the field windings. In the event of its being actuated by conditions of overload, it can easily be reset with a plastic push rod that is provided with the machine. Also incorporated in the model 77 drill is the Bridges Neonic Safety Eye, which is a small indicator lamp on top of the casing, for showing that the machine is earthed and correctly wired to the mains. This drill, which weighs 4 lb 2 oz and is supplied with a removable chuck guard, is available in two forms: the 77C has a pistol grip handle, and the 77S a saw type handle.

In addition, the manufacturers have introduced a heavy-duty model with the same drilling capacity as the model 77 but without the overload protection. Again, two versions of this machine are available—the model DRTC with a pistol grip handle, and the model DRVC with the saw type. This machine, which weighs 4 lb 12 oz, operates at 2,000 r.p.m. when running light, and at 1,200 r.p.m. at full load; it also has the Neonic Safety Eye on the top of the casing.

The Productograph control desk. To the left of the controller is a linear counter panel, on which the progress of each unit in the shop is registered by a coloured mask moving across a scale. This progress is also permanently recorded by a multi-channel pen-recorder to his right, and beneath his right arm is a single-channel high-speed recorder for close examination of isolated traces

PRODUCTION CONTROL

Productograph Equipment Provides Instant Assessment of Machine Loading, and Permanently Records Analysis of the Down-time for a Whole Workshop

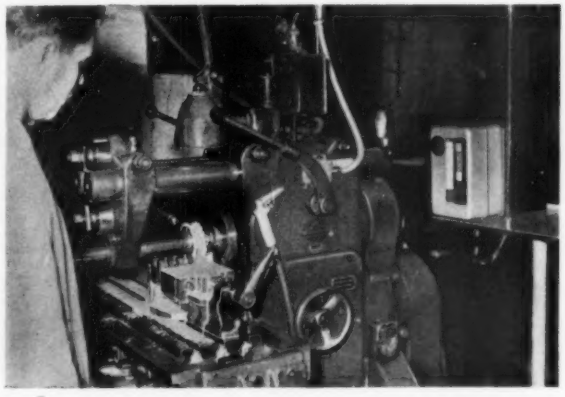
OVER the years, improvements in the techniques of manufacture have frequently been associated with advances in methods of communication. This evolutionary progress has included the large scale introduction into industry of devices such as telephones, closed circuit television, short wave radios and, more recently, electronic computing machines; some of these have been employed with the object of, among other things, reducing the time taken to communicate information on plant utilization from the workshop floor to the production control department. Various methods of transmitting information of this kind are employed in many enterprises, and are successful in reducing down-time.

Analyses of the various causes of stoppages are, of course, time-consuming, and occupy the services of teams of skilled personnel for considerable periods. However, some organizations, mainly smaller ones, appear to take the view that the results afforded by the setting up and regular employment of a work study department do not justify the expense involved, and these firms therefore carry on their business without having any clearly defined ideas of the primary causes of lost time in their workshops. Nevertheless, it has been shown that approximately 80 per cent of the down-time in an industrial concern is the result of circumstances beyond the control of machine operators.

In Germany, the firm of Siemens-Halske has, for some time, been manufacturing Productograph equipment, which is designed to transmit information instantaneously and automatically from the shop floor to a central control desk, and there to analyse this information and record the results on paper roll-charts. In this way, the production controller of a machine shop, for instance, is able to keep a constant watch over the performance of all the units under his control, and is in a position to take immediate action to hasten a supply of material to a machine that is running short, to summon the maintenance department if a repair is required, or to put back into operation a machine that has finished a particular production run.

This equipment, in addition to being of assistance in respect of materials handling, also provides, for future

On this milling machine, the automatically operated impulse generator is a switch that is fitted to the starting handle, seen in the centre



reference, a permanent record of workshop loading. During the past four years, it has been supplied to over 170 organizations in all branches of industry in Germany, and claims are made of a resultant average of 11 per cent improvement of production volume. The Productograph is now to be assembled and marketed in Great Britain by Adrema Ltd, of Telford Way, London, W.3.

General operation

Fitted to each machine in the workshop is an impulse generator which, on completion of each work cycle, automatically transmits a signal, through a cable, to the central control panel. Since the Productograph can be used in conjunction with virtually any repetitive process, there is, of course, a wide choice of means for originating the signals. Micro-switches, pressure switches, flow meters, photo-electric cells and thermostats are obviously suitable impulse generators, a typical application being a micro-switch attached to the starting handle of a machine tool.

On or near each machine there are, in addition, two devices by which the operator can convey information to the control desk; one is a small box on which there are five push buttons, each of which operates a light on the control panel relating to one of five reasons for the machine stoppage. The other is an intercommunication system by which operator and controller can speak to each other. In the central office are the control panel and console, at which sits the planning control engineer. From here he is in contact with machine operators, stores supervisors, maintenance departments, production managers, shop foremen and others concerned with the manufacturing processes.

While a machine is working at the intended rate of production, the impulse generators automatically operate three instruments in the control room. The first of these is a standard, electrically-operated, 6-digit counter that registers the cumulative number of impulses, and the second is a multi-channel pen-recorder unit on the trace of which a blip appears at the completion of each work cycle. The third is a linear counter, on which a visual indication of production volume is given by a transparent blue mask travelling across a horizontal graduated scale. In addition, as long as the impulse generator is working, a 6-digit counter is recording the total productive time per shift.

In the event of a stoppage of work, three situations can arise. If the operator finds that, for reasons beyond his control, his machine is brought to a standstill, he presses the appropriate button on the small box near his machine. The five buttons are labelled according to the purpose of the machine or process being monitored; in the case of a machine shop, the labelling would probably be as follows:

1. Inspection
2. Machine breakdown
3. Tool or material stores
4. Setting
5. Jig or tool adjustment.

On the central panel, the controller sees a light come on, and by its position on a grid is able to tell which machine has stopped, and for what reason, and thus can take immediate action, acquainting the personnel from the stores or maintenance departments with all relevant details. Thus, the delay before effective remedial action is taken is reduced to a minimum. The 6-digit counter is meanwhile recording the total hours of down-time in the workshop for each of the five reasons, and the elapsed time of the new stoppage is now added to this.

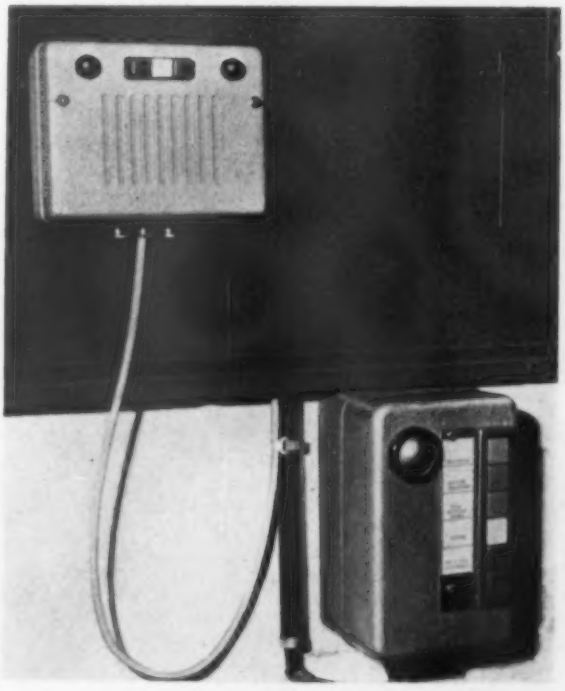
Simultaneously, a second pen on the pen-recorder unit draws a coded trace to indicate the reason for the stoppage. If the controller requires more information from the machine operator he can obtain it by using the intercommunication system, and if in any particular instance the non-productive time of a machine is not required to be included in the figures for total down-time, the relevant circuit can be isolated.

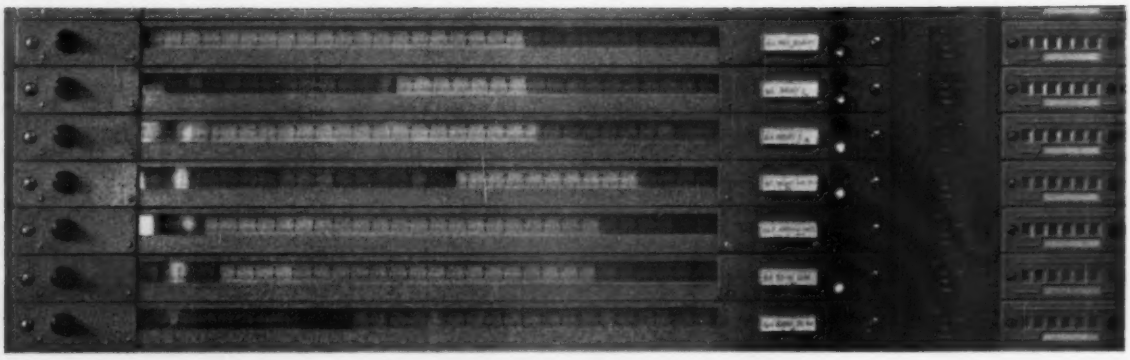
This, in broad terms, covers one of the situations that could occur when there is an involuntary stoppage; another case arises when for some reason the operator fails to press the button. Incorporated in each counter circuit is an adjustable time-delay unit, which the controller can set to the ideal cycle time for that particular impulse. When the cycle time has elapsed, but there has been no signal from the impulse generator and no message from the operator, a warning lamp is lit on the control panel. The controller can then contact the operator for his report.

In the event of a voluntary stoppage, such as might occur when the operator wishes to leave his machine for a while, he presses a sixth, unmarked, button on his box, and this extinguishes the warning lamp just mentioned, and informs the controller that the machine is still potentially productive, and no remedial action is called for. If the controller wishes to converse with the operator, he presses a button to light a lamp on the operator's speaker unit.

It is emphasized that the main purpose of the Productograph is to record and analyse the work loading of machines in a workshop, and not to maintain a watch over the operators of these machines, although the effect of operator fatigue will, of course, be readily apparent. As many as 200 machines or other types of equipment can be dealt with from one central control office, each basic Productograph console unit dealing with 20 such units. A degree of indirect control, such as would be required, for instance, during a

Close to each machine fitted with an impulse generator are these two devices. When the machine stops, its operator should press the appropriate one of five labelled buttons on the lower box, informing the controller of the reason; if he fails to do this, the warning lamp comes on automatically at the end of the pre-set ideal cycle time for the work, and is extinguished by the operator pressing the unlabelled button. Above is the intercommunication unit; its three buttons are for calling the controller, establishing the speech circuit and switching off the tape recorder, which is used when no controller is in attendance





The linear counter. A transparent blue mask moves to the right, as signals are sent by impulse generators. When it overlaps a transparent yellow mask set at the shift target figure, the resultant green strip is indicative of over-production. The warning lamp duplicates the action of that on the operator's box; above it is a button for resetting the blue mask to zero, and at the other end of the scale is a knob for adjusting the position of the yellow mask. Beside each scale is a decade plug, which controls the separate reduction factors of the linear counter and the pen recorder. The digital counters register the cumulative number of impulses from each signal generator and the total productive time for each machine in the workshop

night shift, when there might be no control engineer in attendance, is afforded by the inclusion in each console of a tape recorder unit.

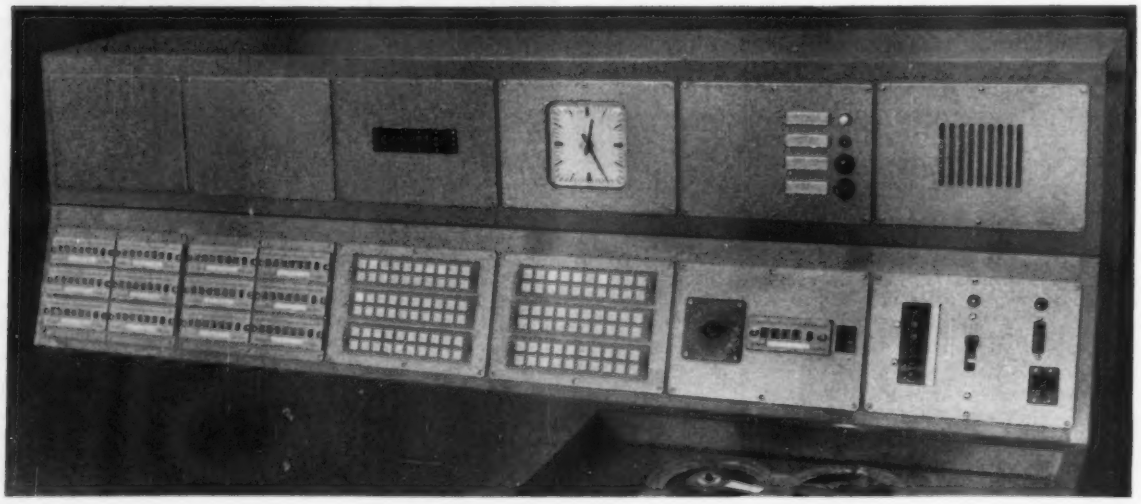
This can be switched into the control circuit in such a way that it records the voice of the operator explaining the reason for his work stoppage; the operator's voice, in this case, starts the machine recording. When the controller is again present he can play back the tape and annotate the trace on the pen-recorder, according to the information he has thus received. There are, of course, many other purposes to which the tape recorder can usefully be put. Incorporated in the main panel is a clock by which the Productograph can automatically be started and stopped at times coincident with the beginning and end of shifts.

The linear counter

As already mentioned, a transparent blue mask slowly traverses a horizontal scale on the linear counter. The scale is divided into 30 equal parts, each subdivided into ten, and the blue mask travels across from the left. At the right-hand end of the scale there is a yellow mask, the edge of which is pre-set to a position to indicate on the scale the target figure for the shift. When, at the end of the shift, these masks overlap, the length of the resulting green band is indicative of the degree of over-production. If, on the other hand, the lines do not meet, then, of course, under-production is indicated. The state of over-production can be automatically signalled to the operator, who is thus informed that he can change his machine settings for another production run.

At the left-hand end of the scale is a knob for adjusting the yellow mask to the target figure, and at the other end is a push button to reset the blue mask to zero at the end of a shift. Below the resetting button is the warning lamp that goes on when the ideal cycle time has elapsed, but the automatic impulse has not been signalled. This light goes out as soon as the operator has indicated his reason for the stoppage. Twenty linear scales, one above the other, occupy

From left to right, the features on the main control panel are: two duplicated groups of digital counters, one in each group to record total productive time, the other five to analyse down-time, of the whole workshop; a grid consisting of twenty vertical rows of six lamps to show the location of the stoppage, and which of the five reasons is responsible; a selector switch controlling the single channel recorder, with its decade plug and duplicated digital counter for cumulative impulses; the fuses, main switch, and switch to silence the buzzer that warns of circuit failure. Upper row: plugs to isolate circuits not being used; clock; buttons to select alternate banks of counters during shift changes; loud speaker of intercommunication system



the left-hand half of the standard vertical counter panel. On the right-hand half, opposite each linear scale, is a row of four 6-digit counters.

One pair of these counters is used in alternation with the other pair, from shift to shift: the left-hand one of each pair records cumulative impulses, and the right-hand one the total productive time for that machine, in standard increments of 0·01 hr, or any other time scale chosen. Each counter unit embodies a button to reset it to zero.

Down the middle of the panel is a row of decade plugs, one per machine, by means of which each increment on the counters can be made to represent either 1, 10, 100, or 1,000 impulses, as required. One of the two contacts in each plug determines the multiplication factor of the linear and digital counters, while the other controls that of the pen recorder,

The multi-channel pen-recorder, and the controls for the intercommunication system. Beneath the microphone are tone and Volume controls for the loudspeaker, and on each side of it are the buttons for calling up operators and establishing speech circuits; between the rows of buttons are their indicator lamps. The four separate buttons on the right are remote controls for the tape recorder, which is not shown here

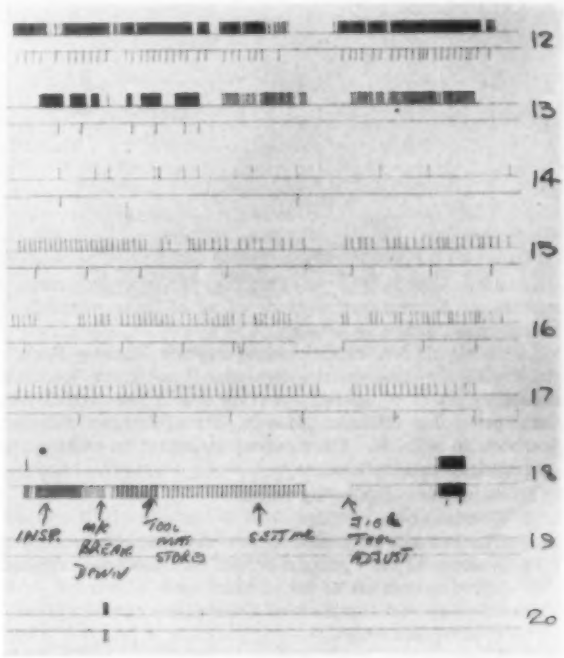
which is situated on the console. The panel on which these linear and digital counters are mounted is fixed to a light-weight tubular steel stand, and can be moved to any position around the console, as dictated by convenience and the number of other similar panels in use at one time.

Main console

The Productograph, of course, is not intended to supplant the work of the production control personnel, nor is it suitable for operation by anyone unskilled in this type of work. Only if a person of considerable experience occupies the control desk, is it possible for the rapidity with which the information can be acted upon to be fully exploited. Given a set of circumstances to contend with, the controller knows precisely what steps to take in order to restore production to its normal level as soon as possible.

A controller sitting at the console desk has, in front of him, the main panel, on which are two banks of digital counters and an indicator lamp grid; as before, one bank of counters works in alternation with the other, in successive shifts. Each bank comprises six counters, one recording total productive time for the workshop and the others the total down-time for each of the five reasons. There are twenty vertical rows of squares in the indicator lamp grid, one row per machine. Each row has six squares: when the topmost one is illuminated it means that the relevant machine is productive, and when one of the other five is lit, the machine is idle for the appropriate one of the five reasons. Above the grid there are 20 isolator plugs, by means of which any machine likely to be out of use for a long period can be removed from the counter circuits; next to them is the clock, and to the right of the clock is the shift-change button. When this is pressed, the alternative banks of digital counters are brought in; a key is fitted near the button, which locks the selection of a bank of counters, and prevents tampering by unauthorized persons.

To the right of the controller are the intercommunication panel, the tape recorder, the main pen-recorder unit and a subsidiary single-channel pen recorder on which the trace from any one machine can be reproduced at greater magnification, if the need for more careful study arises. In addition to these, at the far right of the main panel there are the main fuses, the main switch, and the loudspeaker. Here, too, is the selector switch for the single-channel recorder and, operated by the same impulse generator, a digital counter which, of course, is temporarily a duplicate of



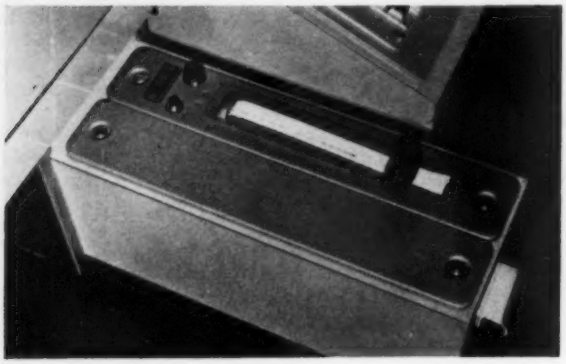
Part of a multi-channel graph, in which samples of the five coded traces are specially included in channel 18. Each pair of tracks represents one unit in the workshop, and a blip appears on the upper track each time a signal is received from the impulse generator. In some applications these blips occur so frequently that they are indistinguishable, as shown in channels 12 and 13; on the lower track, therefore, the blips appear at predetermined intervals of 10, 100 or 1000 impulses. During down time, the appropriate coded trace replaces the counting record on the lower track, and thereby alerts the controller

one of the units on the linear counter panel. The single-channel recorder also has a decade plug in its circuit.

At the back of the main panel are the adjustable time-delay controls, each of which is set to the ideal cycle time appropriate to its impulse generator circuit. Since these controls are used only infrequently, there was no point in mounting them in a prominent position on the panel. A safety feature is incorporated in the control system: should any of the counter circuits be put out of order, a buzzer on the control desk is automatically sounded.

Pen recorders

The moving roll of waxed paper in the multi-channel recorder has a speed of 0·5 mm/min. As mentioned previously, there are two pens per machine, the upper one tracing a blip for each cycle impulse, and the lower one



Any one of the pairs of tracks on the main recorder can be simultaneously reproduced at a larger scale on this high-speed unit

normally making blips representing 1, 10, 100 or 1,000 impulses, according to the setting of the decade counter. During periods of no production, this lower pen traces a waveform that has five variants, one for each of the five buttons. These variants are characterized by the proximity or density of their blips.

It may be found desirable to examine the traces made by one impulse generator more closely when, for example, a new machine has been introduced into the workshop and a special study of its behaviour would be of value; for this purpose the paper on the single-channel recorder has a speed of 30 mm/min, much higher than that of the main recorder.

Grinding Carbide Turning Tools

FOLLOWING the introduction of cemented carbide cutting tools, a great deal of research has been aimed at finding the most efficient methods of grinding them. The primary considerations are that such methods must be quick, economical and without detriment to tool performance. Conventionally, grinding wheels of diamond and silicon carbide are used, but the range of methods available is widening to include the use of abrasive belts and spark-erosion machines. A comparative study of all of these methods is therefore needed.

In its Report No. 49, "Grinding Carbide Turning Tools", the Production Engineering Research Association describes a programme of comparative testing that it has carried out, with particular reference to the effects of these different methods on tool life. The factors considered, in making the appraisal, were as follows:

1. Initial cost of grinding wheel
2. Grinding time
3. Number of tools ground before the wheel was scrapped
4. Number of tools ground before the wheel was dressed
5. Effect on tool life of the method used
6. Effect on tool condition of the method used
7. Tool surface finish
8. Availability of equipment
9. Effect on operator of dust, fumes and noise; safety of the grinding operation; pressure required on tool.

The work was divided into two sections, the first dealing with the effect on tool life of six different methods of grinding, and the second with the rate of removal of cemented carbide by three different media.

In the first section, the test piece for each tool was a bar of En. 25 steel, of 7 in diameter; all test pieces were taken from one cast. As a criterion of tool life, the actual cutting time between regrinds was measured, each regrind taking place when the wear band on the nose or side cutting edge flank was 0·02 in deep; clamped-type chip-breakers were used throughout. Six methods of grinding were examined:

a. 120-grit metal-bonded diamond wheel
b. 60-grit silicon carbide wheel
c. Rough grinding with a 60-grit silicon carbide wheel, followed by finish grinding with a 120-grit metal-bonded diamond wheel
d. Rough grinding with a 60-grit silicon carbide wheel, followed by finish grinding with a 120-grit silicon carbide wheel
e. Rough grinding with a 60-grit silicon carbide wheel, followed by finish grinding with a 180-grit silicon carbide abrasive belt
f. Rough and finish grinding by electro-spark erosion.

One of the shortcomings experienced in the use of the abrasive belt was the difficulty of grinding the rake face of the tool, since only the extreme edge of the belt could be used for this. The tests showed that in respect of their effect on tool life, there was no marked difference in these methods.

With regard to the second section, the three media used for the removal of cemented carbide were:

a. 120-grit metal-bonded diamond wheel
b. 60-grit silicon carbide wheel, dressed with diamond and star-wheel dressers
c. Electro-spark erosion.

The criterion in this case was the thickness of carbide removed during a specified time: three tests of three minutes each were made for each medium, and the reduction in thickness was measured every ½ min. In the conclusion of the report, the diamond wheel was shown as giving the best performance; there was little to choose between electro-spark erosion and the 60-grit silicon carbide wheel.

Referring to the methods of wheel dressing, the report shows that a silicon carbide wheel dressed with a star-wheel gives faster carbide removal than one dressed with a diamond, and mention is made of the fact that the grinding rate of the silicon carbide wheel decreases rapidly after the initial dressing. The recommendation is made that, subject to the nine conditions mentioned earlier, a metal-bonded diamond wheel should be used for grinding carbide tools.

Factors not directly connected with the economy or efficiency of grinding were also discussed in the report. Tool surface finish, for instance, does not appear to be a major item in this study, except in that certain applications of the spark erosion technique would require a finish operation, for a better surface finish. Surface cracking is experienced as a result of rough grinding with silicon carbide wheels, but does not appear with use of the other media. If ease of control is the primary consideration, diamond wheel grinding is to be preferred because, with spark erosion, oil tends to obscure the edge being ground. Grinding with a silicon carbide wheel requires greater pressure and effort by the operator than do the other methods. Copies of the complete report are available, price 7s 6d, from the Association, at Melton Mowbray, Leicestershire.

Rocket Cars

A SIMPLE summary of the technique of rocket propulsion was given in a paper produced by Paul Adorian in 1929. It contains, among other things, brief details and illustrations of rocket-propelled cars. Copies, in the form of 20-page reprints, can be obtained, price 8s each, from the author, whose address is 21 Denmark Street, London, W.C.2. The proceeds will go to the Henry Tizard Memorial Fund.

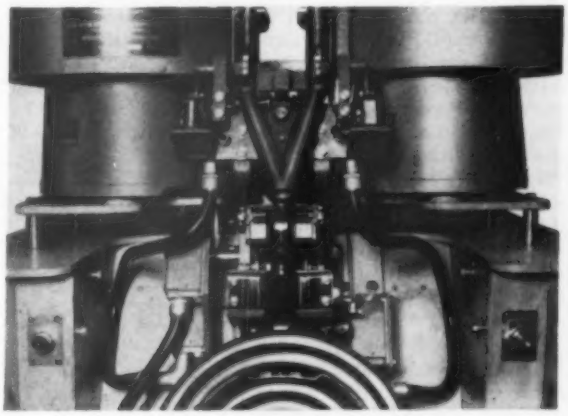
Fitting Tubeless Tyre Valves

A New Semi-automatic Assembly Machine Developed by Hymatic Engineering Co. Ltd. for Standard-Triumph International

IN line-type production even a relatively simple manual assembly operation can, on occasion, constitute a bottleneck that can be relieved only by a costly duplication of work stations and personnel. Specially contrived mechanization would appear to offer the only satisfactory solution to the problem. Recently a machine designed by the Hymatic Engineering Co. Ltd. of Redditch, Worcestershire, for fitting and inflating tubeless tyres at the Rootes Group plant at Ryton-on-Dunsmore was described*. This new machine for fitting tubeless tyre valves to wheel rims, also developed by the Hymatic Engineering Co, has just been supplied to Standard-Triumph International Ltd. at Coventry.

Valves of two different sizes, $\frac{1}{2}$ in and $\frac{3}{8}$ in, are charged respectively into two bowl feeders mounted on the head of the machine. Here they are automatically oriented and feed into separate chutes each terminating in a pneumatically operated escapement device.

When a wheel is loaded on to the inclined table at the front of the machine it is supported from the rim and not from the wheel body, or spider. It is turned about its axis until a spring-pressed, coned plunger engages in the valve aperture. The depth to which the plunger enters the aperture determines the size of valve required and actuates the appropriate component escape device. A valve is fed down to, and is secured by, a pair of spring-loaded clamping jaws.



The valve is shown carried on the probe of the loading arm and about to pass between the soaping brushes and be inserted in the wheel rim

The operator then depresses a pedal control valve to actuate a pivoted radial arm carrying on its extremity a probe. Angular movement of the arm inserts the probe in the tyre valve resilient bushing, opens the clamping jaws, and then lubricates the bushing by passing it between two brushes charged with a soap solution. Continuing the movement, the end of the tyre valve contacts the coned location plunger and, displacing it, is inserted in the wheel rim. On release of the pedal control valve, the radial arm is swung back to its rest position and the machine is then ready to commence a new cycle.

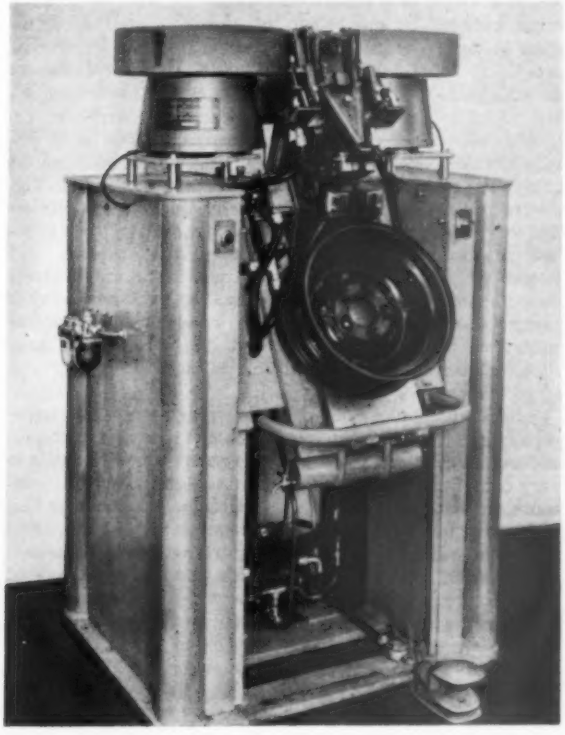
Against the contingency of an interruption or a stoppage of the operating cycle, a reset push button is provided on the machine. Depression of this button will swing the radial arm clear, allow the clamp jaws to close, and ready the equipment for another start.

Soap solution for lubricating the valve bushing is held in a tank at the rear of the machine and the supply to the brushes may be regulated by a metering valve fitted to the underside of the tank. A certain excess amount of solution which passes through the brushes is collected in a cylindrical tank positioned below the inclined loading table. An incidental advantage of this mechanized method of lubrication is that the operator has no need to wear protective gloves. Furthermore, having no solution on his hands, wheels can be loaded and unloaded more easily and more safely.

As regards capacity, the machine can handle wheels of 13 in, 14 in, or 15 in diameter having rims of from 3 in to 5 in width. The overall operating time — loading, automatic cycling and unloading—is 5 sec; the production rate at 100 per cent efficiency being 12 insertions per minute. Air cylinders, solenoid valves and pneumatic circuitry are by Martonair Ltd, as on the tyre machine mentioned earlier.

* *"Automobile Engineer", May* 1961.

General view of valve-fitting machine with guards removed. The wheel is located by a spring-loaded plunger engaged in the valve aperture



Forming Toothed Components

Progress Towards the Rapid Production of Accurate Gear Forms by the Cold-forging Process

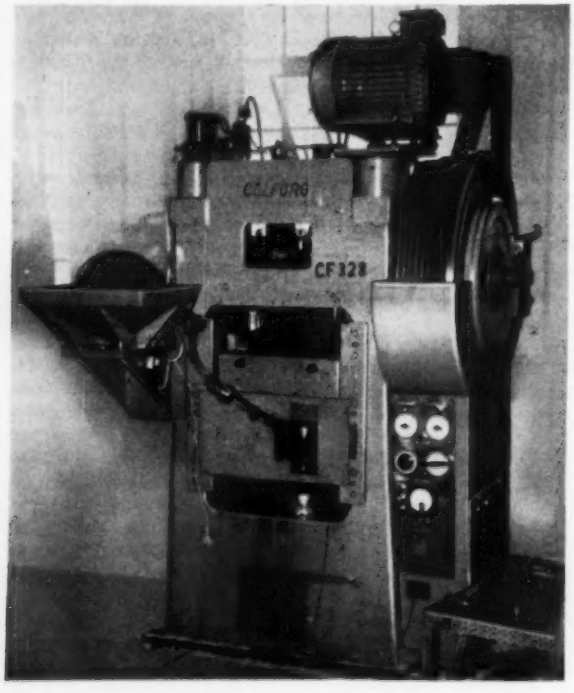
THE mass production of gears has always presented difficult problems which have been tackled in many different ways. Ideal gear forms have been calculated to very high standards of precision but the efficiency of a gear system depends to a large extent on the accuracy with which the finished components conform to the ideal shape. The most common method of gear production is by the removal of metal by cutting and shaving or grinding to form the individual teeth, but this requires costly machines and tooling, is time-consuming, and wasteful of stock material. However, it has the advantage that the gear can be produced with accuracy, and distortion due to heat treatment can be rectified with relative ease. A good surface finish can also be obtained.

In recent years there have been many endeavours to produce a finished gear by various forging methods, but these attempts have not been entirely successful. Finish machining has been required to secure accuracy of form. The cold-forging process presents new possibilities and the specialized research undertaken by Cold Forging Ltd, is of considerable interest. Development work, in particular on small spur and bevel pinions, is being actively progressed at both their European and British plants. Some examples are illustrated.

It would seem reasonable to forecast that with the new, specially developed, cold-forging presses now available, gears will be produced to a very high standard of surface finish and accuracy in the not distant future. They will, of course, also benefit by the improved material strength and favourable grain structure normally associated with the cold-forging process. It is not uncommon in cold forging to raise the tensile strength of a mild steel component from its original value, between 22 and 28 ton/in², to over 45 ton/in² or, in some instances, even 50 ton/in². It is possible, by careful design, to work-harden certain zones of the component advantageously. If necessary, certain zones can remain at, say, 30 ton/in² tensile and others raised to the maximum.

Specimens of forged gear forms. The door bolt is in mass production

Colforg P300 press with automatic feed, producing gear-type door bolt



With alloy steel an increase in tensile strength of 50 per cent has been achieved. For some components this can be completely satisfactory, without further heat treatment. The degree and variation of work-hardening depends entirely on the conditions specified by the customer and the configuration of the component itself. Alloy steels can be cold forged satisfactorily. The higher nickel-chromium steels present some problems since they tend to work-harden very rapidly and thus require inter-stage annealing, but carbon-manganese steels such as En32 and 201 and also the lower nickel-chromium steels like 351, 361 and En35 will cold forge quite well.

The production of gears by cold forging presents attractive possibilities; the concomitant problems, however, should not be underestimated. First, the generation of the dies is very complicated. Secondly, accurate dimensions and contours are somewhat difficult to maintain, due to expansion and contraction within the tools themselves and the inevitable wear that will occur as the operation progresses. Research is proceeding into new tool materials and the techniques of manufacture in order to solve these problems. Increasingly long runs with accuracy of production are already being achieved experimentally.

Probably the chief difficulty encountered in gear production is that the tool configuration tends to produce inherent weaknesses and unbalanced tool loadings. Design must be

considered very carefully to minimize this factor. In addition, higher frictional values must be allowed for and, due to the extremely severe working, more than usual care must be taken to avoid rupture of the lubricant film.

Specially designed cold-forging presses, known as the Colforg range, are being used in this development. They are capable of operating between 30 and 60 stroke/min. Many parts already cold forged have been in full production at 60 stroke/min for some time and, therefore, a considerable backlog of experience has been accumulated regarding the working life of tools. Tool life is being extended continuously, and the minimization of wear over long runs is, of course, an essential pre-requisite to the economic cold forging of gears on a mass production scale.

Experience at Cold Forging Ltd plants has proved beyond question that long runs are possible only when presses specifically designed and built for cold-forging operations

Punch Steels

Material	*C*	*Si*	*Mn*	*Cr*	*Mo*	*Ni*	*V*	*W*	*Co*
Hydra Vantage	1·25			4·5			4·0	13·5	
Motor Magnus	0·8			4·0	5·5		1·4	6·0	
Capital 562	0·8			4·2	5·0		2·0	6·0	

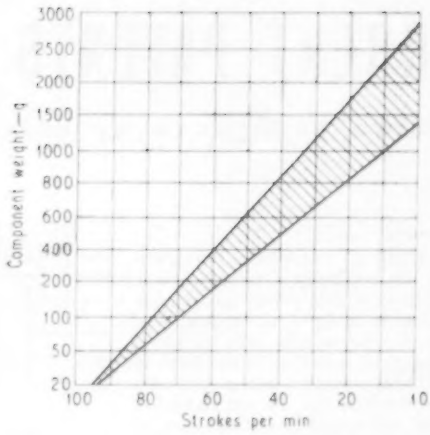
Die Steels

Material	*C*	*Si*	*Mn*	*Cr*	*Mo*	*Ni*	*V*	*W*	*Co*
Cooks K	1·9	0·65	0·35	13·5					
Motor O8S	1·4		0·2	14·0	0·65	0·3			3·2
NM 240	1·6	0·3	0·35	11·5	0·7		0·45	0·5	

Suitable steels for cold-forging punches and dies for gear-form parts

are used. The special system of pre-stressing and the general rigidity of the Colforg presses not only enables a component to be produced with accuracy but, by reducing lateral stresses in the punch and die, increases the tool life considerably. Other substantial advantages stem from this high-productivity machinery. Compactness of installation is one important feature.

The ability to produce by cold forging, shapes that hitherto have been extremely expensive to make and which required complicated machinery, can be used by designers to eliminate many problems in the manufacture of blind-toothed parts, full bodied or flanged pieces, and parts having varying



Graph showing capacity—part weight and stroke rate—of P300 press

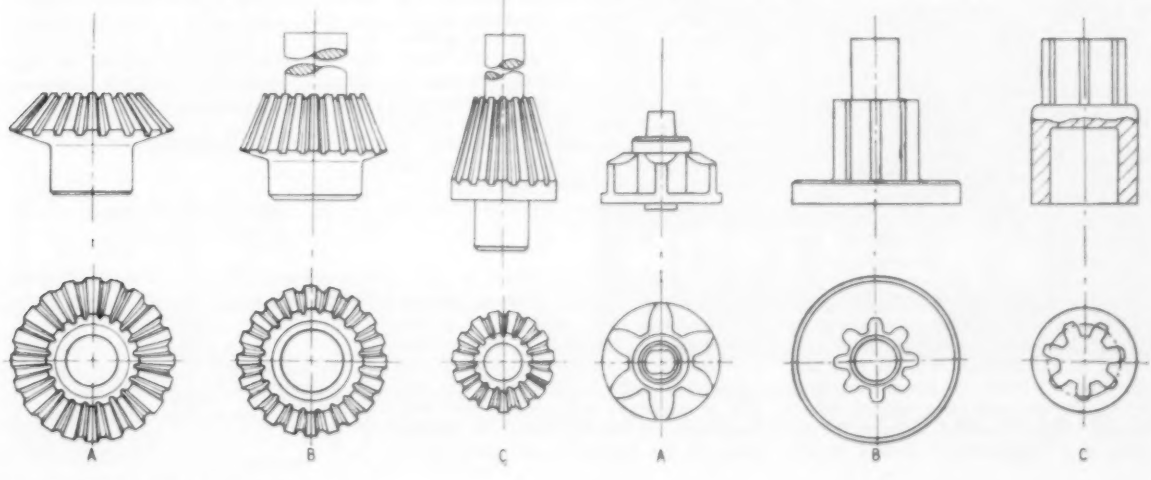
diameters. Often, a subsequent machining operation can be eliminated; a good example being the production of flats on gear spindles. The automated flow system developed in cold-forging practice is particularly suitable for handling various gear shapes.

The flanged, gear-type, door bolt illustrated, a feature of one of the best-known British mass-produced automobiles, is in regular full production at the Hanworth Road works of Cold Forging Ltd, at Sunbury-on-Thames, Middlesex. Hot-rolled steel bar stock is automatically cropped, flattened, and coined to remove any ovality, on a single machine. After annealing, the preforms undergo a preliminary shaping on a press and are then again annealed. Final forming to finished dimensions is in closed dies on the P 300 press illustrated. Production flow is organized to suit the presses which are operated at the rate of 60 stroke/min.

Time is saved by cropping small-diameter stock, but the deformation resulting from the cropping of short-length slugs must be eliminated by flattening and preforming. The machines used, handling bar up to 3 in diameter, crop slugs in lengths down to one-fourth their diameter.

To summarize, the developments already in progress would seem to indicate that the cold-forging process is well on the way to breaking into the field of economic manufacture of accurate gear wheels and pinions, at mass production rates.

Typical examples of (left) bevel-type and (right) spur-type gear forms produced by the cold-forging process at the Sunbury-on-Thames plant



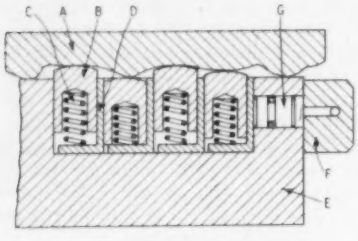
CURRENT PATENTS

SELECTED ABSTRACTS OF RECENTLY ISSUED SPECIFICATIONS

Flat chuck

A CHUCK for supporting workpieces that are fragile or of irregular shape is the subject of this patent specification. The chuck is designed to be used particularly in conjunction with magnetic chucks, or to be embodied in the structure thereof. It is basically a group of parallel spring-loaded plungers that are allowed to find their own height under the action of the pressure of the workpiece, and then locked in position hydraulically.

Each plunger B is drilled axially to take its Spring C, which abuts against the foot of an L-shape packing piece D whose upright portion separates adjacent plungers. The plungers and packing pieces rest in rows in a flat-bottomed cavity in member



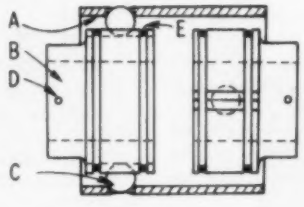
No. 868162

E, and the walls of the cavity afford lateral location. In one wall are circular recesses containing pistons G which, when acted upon by hydraulic power, compress the plungers and backing pieces laterally, and lock them in the position determined by the shape of workpiece A. The plungers can be of circular section, or square or triangular, according to the number in the group or their particular application, and the hydraulic pressure can be applied manually, if desired, by a screw plunger in manifold F, which couples all piston recesses. *Patent No.* 868162. *A. A. Jones & Shipman Ltd.*

Universal coupling

IN lightweight mechanisms, such as throttle linkages or those in instruments, the need may arise for a simple flexible coupling without backlash. Misalignment of nominally co-axial shafts is a typical condition for which the coupling in this patent specification is intended. Its driving and driven components are identical, and are enclosed by the connecting member, a short tube A.

Over the end of one of the shafts to be coupled there is a sleeve B, secured by a pin in hole D through both the shaft and the sleeve. Drive is transmitted from B to A by two steel balls, each of which registers with a drilled hole in A and rolls in a longitudinal V-groove in the



No. 869016

periphery of B. The holes and grooves are, of course, on a common diametral axis, and longitudinal travel of the balls is limited by circlips E around B; the diametral axis of the balls in one end of the tube is, of course, at right angles to that in the other. This coupling is not intended for the transmissions of high torques, nor for use with shafts whose axes are grossly out of alignment. *Patent No.* 869016. *C. F. Osborne.*

Valve rocker arm

IN the past, valve rocker arms have pivoted about a pin, so that fine manufacturing tolerances were needed and the provision of ample lubrication was imperative. In this invention, the components are of pressed construction, and, since they have a rolling action, the need for pressure lubrication is obviated. Rocker arm A is of channel section, and a tubular component C bears against the web, to form a central fulcrum.

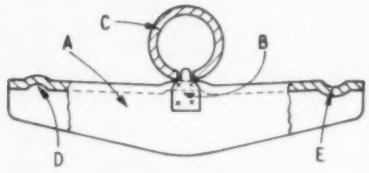
Welded to each flange, or formed integrally with A, is a location peg B, which projects into a slot at the end of C; longitudinal and lateral free-play are thus determined by the clearances between pegs and slots. The pegs can be stamped with their profiles sufficiently accurate to ensure adequate longitudinal control throughout the travel of the arm. At the ends of the rockers are depressions D and E, of patterns suitable for registering with the ends of push rods and valve ends. Since the effective radius of each arm of this lever mechanism varies during its travel, there is scope for designing rocker arms so that a near-linear motion is described at the point of contact with the valve, thereby obviating excessive side-thrust on valve guides. *Patent No.* 864158. *Ford Motor Co.*

Rear suspension

A SIMPLE method of springing for cars with rear suspensions of the swing-axle type is described. It comprises a single bar of spring steel formed and mounted in such a way that a low ride rate is combined with a high roll rate. Extensions of the spring act as trailing arms for the half-axles, and provision is made for the ride height to be adjusted, to accommodate the variations of load carried in the vehicle.

There is a pair of brackets G and H, inboard and outboard respectively, on each half-axle C, approximately mid way between the chassis-mounted differential unit B and the wheel. The spring steel bar D is clamped by bracket G in a fore-and-aft orientation, and is bent outward at right angles immediately behind it; H extends further back than G and, of course, clamps D in a transverse direction. Outboard of H, the spring is bent through 180 deg, and crosses behind the differential unit, to be bent and clamped in a similar manner on the other half-axle. Changes of camber, arising from vertical deflection of the wheels, are thus lightly resisted by bending of the spring, and roll movements are more heavily resisted.

Forward of the axle C, D extends to pivot brackets E on chassis frame A, where each end of the spring is bent inwards at right angles, to act as the pivot pin. Additional roll stiffness and ride stiffness are obtained by virtue of the torsional resistance of these forward extensions, which act as trailing arms. If the brackets

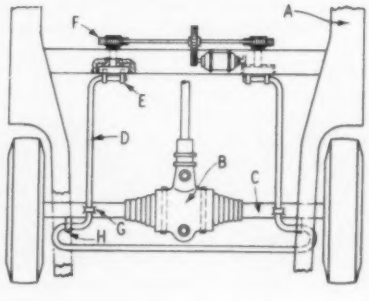


No. 864158

E are rotated about longitudinal axes, the camber of the wheels, and therefore the ride height of the car, are changed.

In the illustration is shown a mechanism for effecting this change; brackets E are mounted on the ends of shafts, to which are fitted worm gears F, and are rotated by worm wheels. The worms are driven by an electric motor mounted on the chassis. *Patent No.* 868433. *Daimler-Benz A.G. (Germany).*

No. 868433



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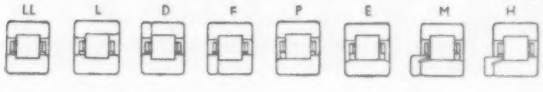
No 8

Roller Journals with Special Lip Arrangements

These 'Lip' and 'Shoulder' patterns are variations of the standard roller journal described in No. 7 of this series of advertisements, and except for the 'LL' patterns, have the same load capacities.

Patterns 'L', 'D', 'F', 'P', 'E', 'M' and 'H' (seen below), are designed primarily for convenience of assembly and dismantling, and where lips are provided on both inner and outer races, they can be used for location duty. The latter is also true of the 'LL' pattern but as this cannot be assembled with as many rollers as the other roller bearings its load carrying capacity is less, although greater than that of a ball bearing of the same dimensions. Lipped roller bearings, though quite suitable for normal location duty, are not intended for continuous thrust load.



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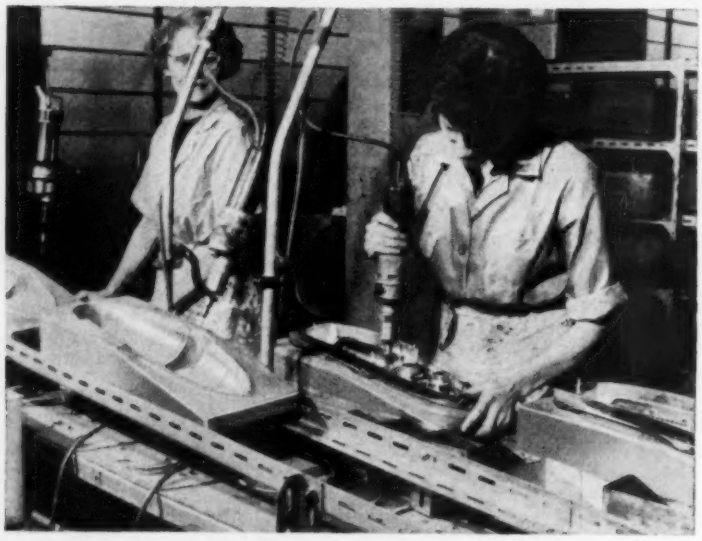

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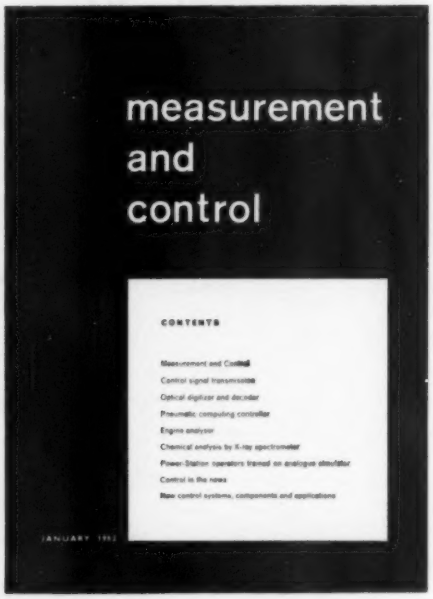

measurement and control

To be published monthly beginning January 1962

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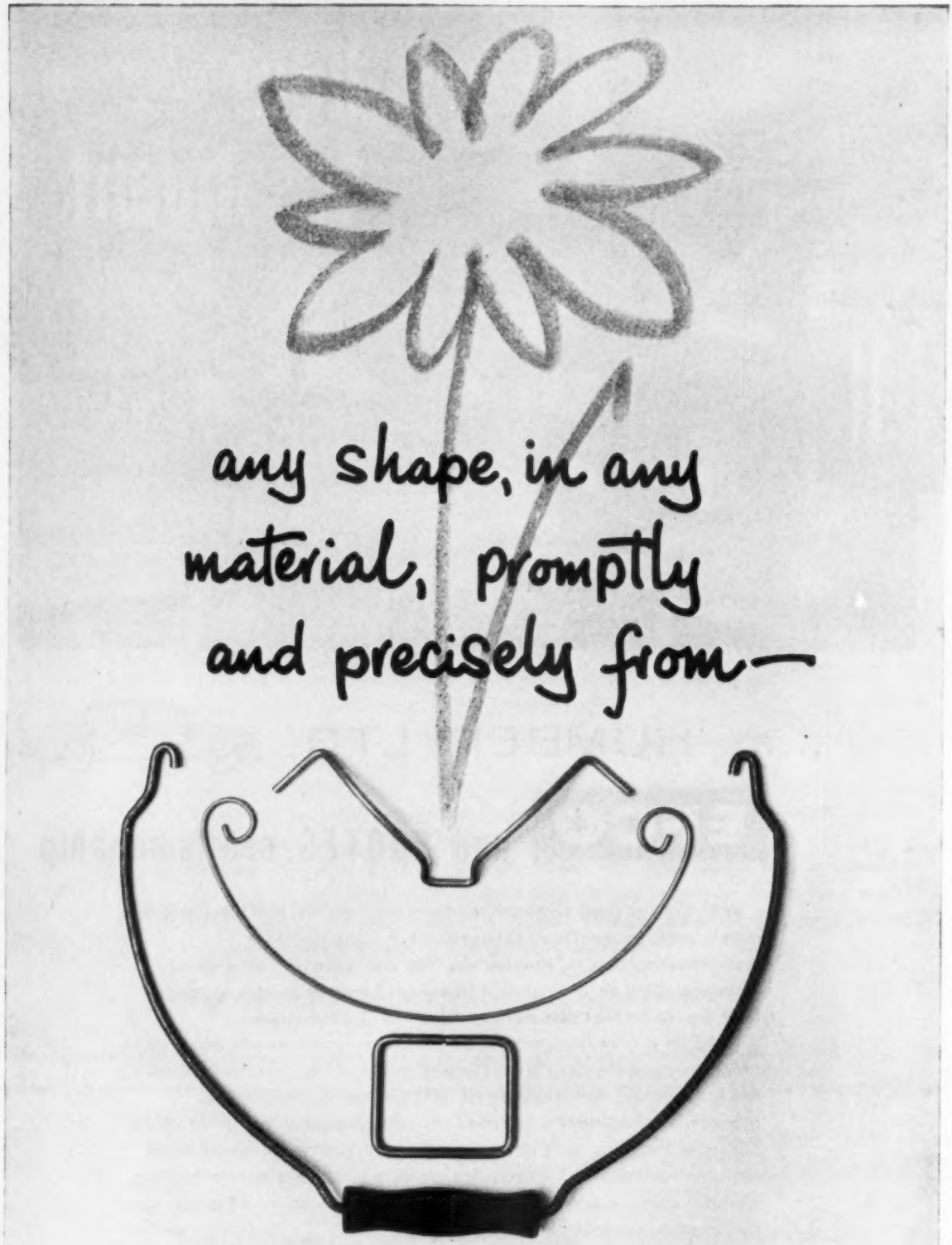

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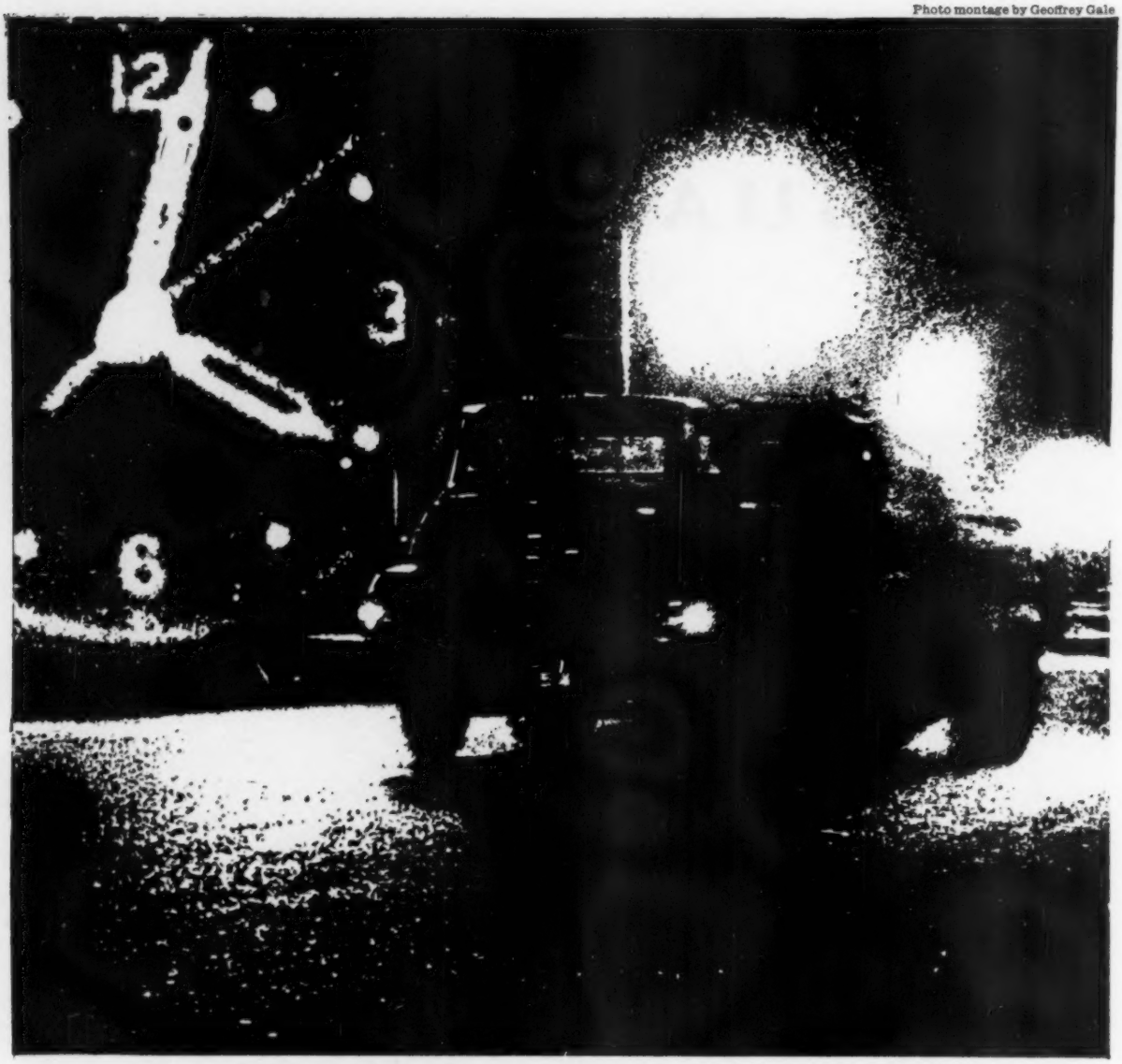

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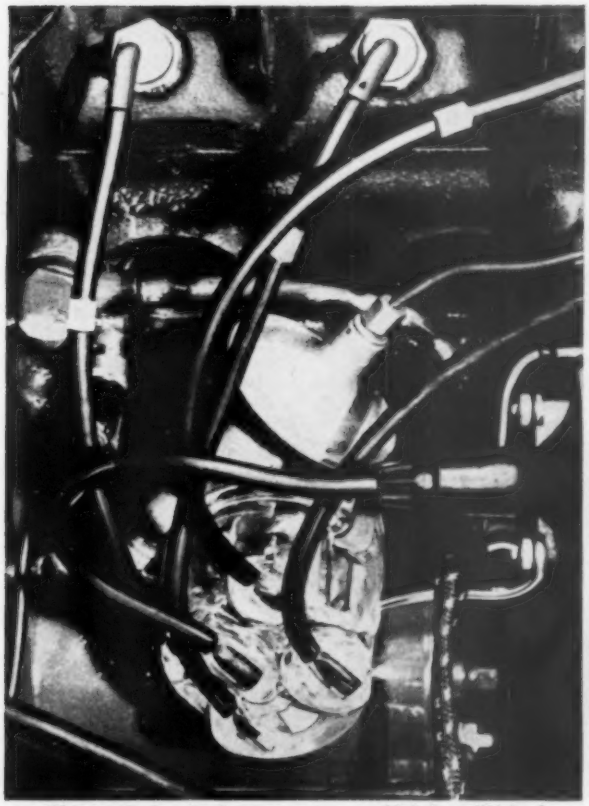
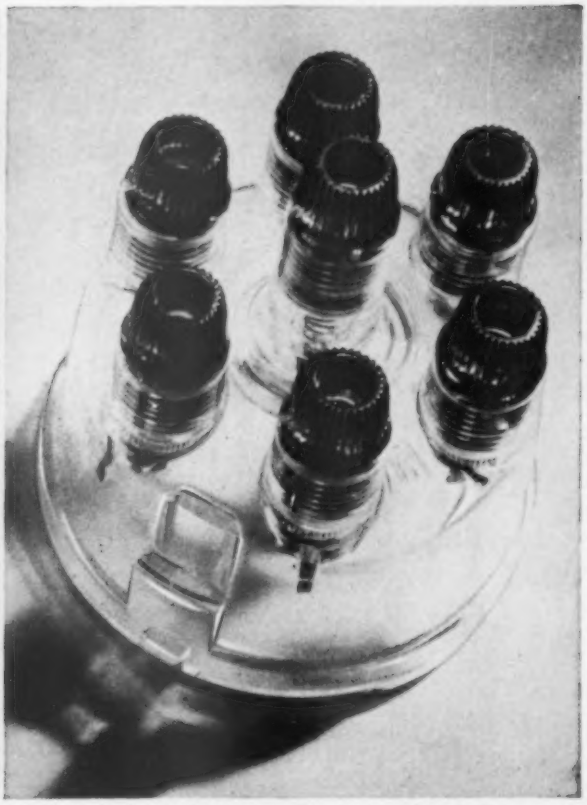


This 4-cylinder distributor cap was moulded from 'Diakon' acrylic polymer by Clearex Products Ltd., Heather Park Drive, Wembley, Middlesex, for Remax Ltd., Remax House, Alfred Place, London W.C.1.



A 6-cylinder distributor cap. The high moulding efficiency of 'Diakon' acrylic polymer makes intricate components such as these available at reasonable cost.

These distributor caps are moulded from 'Diakon'

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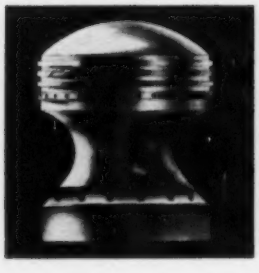

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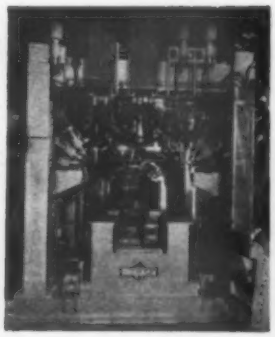
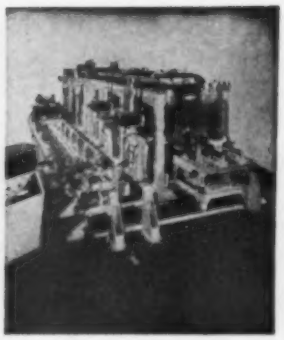
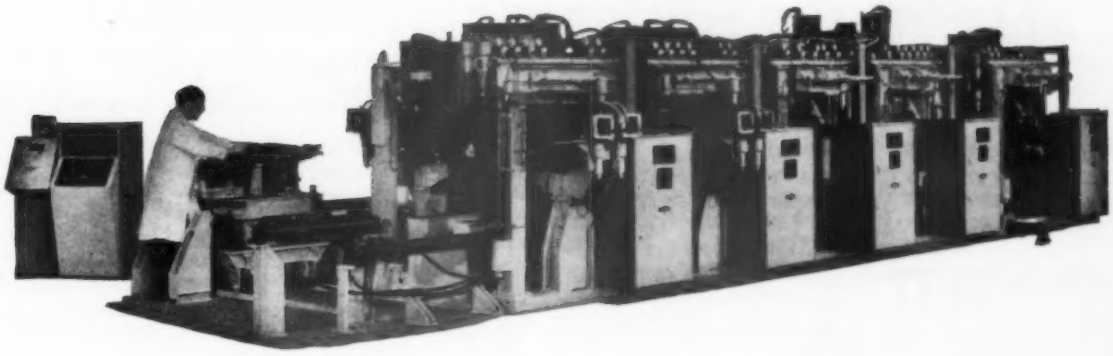
Illustrated is a transfer resistance welding machine, recently designed and constructed by Sciaky. It welds the front suspension and engine mounting units of the BMC mini cars in 5 stages. Welding cycle and transfer between stages is automatic.





a welding machine... ...a production line



Every day thousands of Sciaky Resistance Welding Machines are used to produce Britain's automobiles. Working closely with the motor industry, Sciaky has developed a range of welding machines to meet their critical requirements. But, the story does not end there . . . the adaptation of resistance welding to a specific application—the Sciaky technique—is yours for the asking. Let Sciaky experience and know-how work for you, because Sciaky resistance welding techniques are developed to meet your individual needs—whether portable, pedestal, or complete production line.

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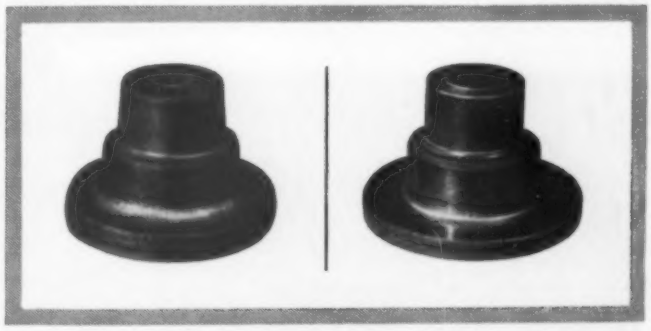
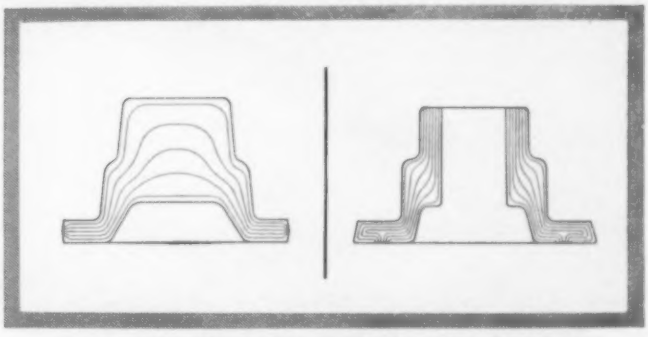


The Motor Car Propeller Shaft Flange shown above (left), was formerly made from Heat Treated EN8 steel. It is now produced from low carbon steel whose properties after extrusion (right) are equal to those of the EN8.



The pattern of flow lines in an extrusion (illustrated above) follows the external contour closely and is superior even to that of a forging where generous machining allowances are usual and really deep piercing is impossible.

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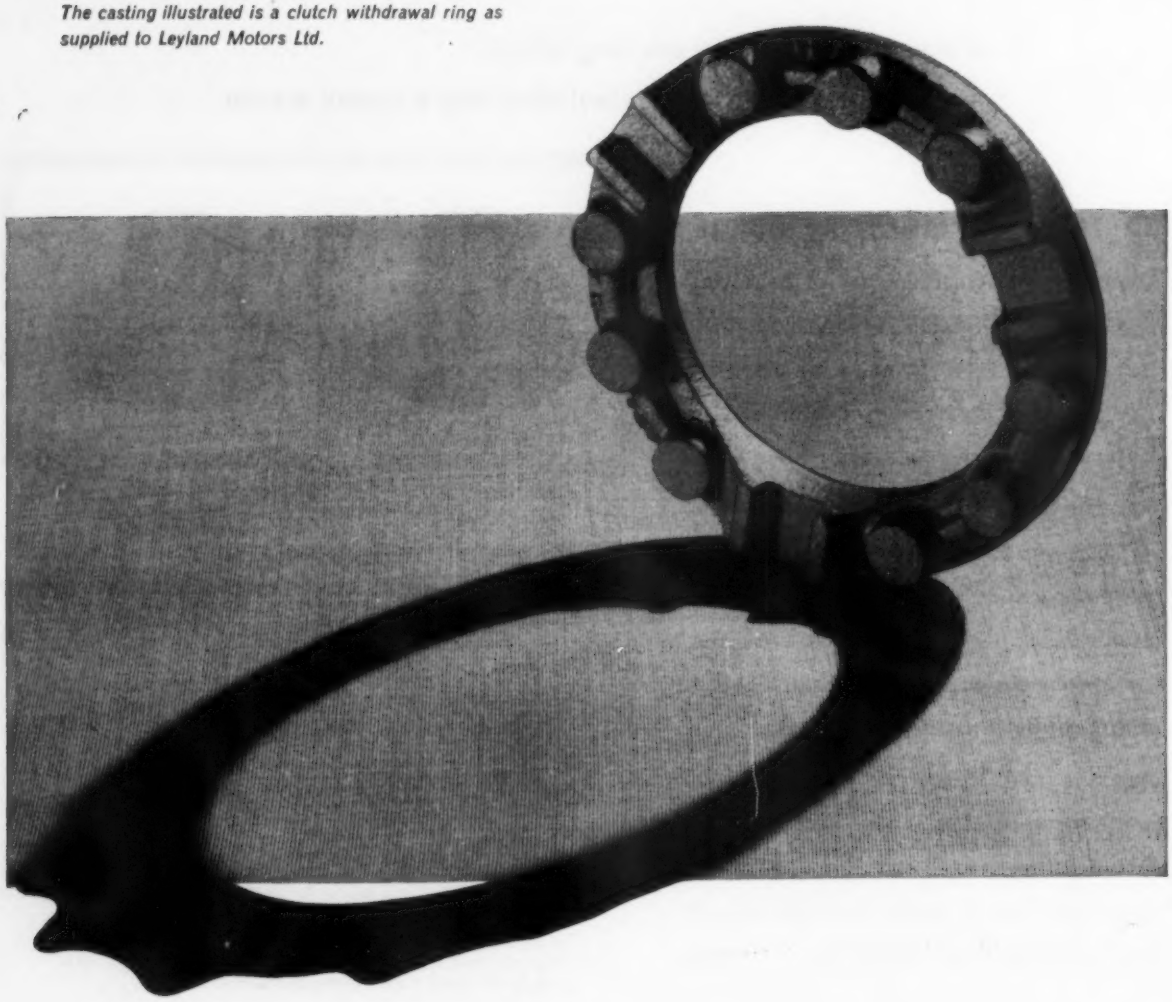

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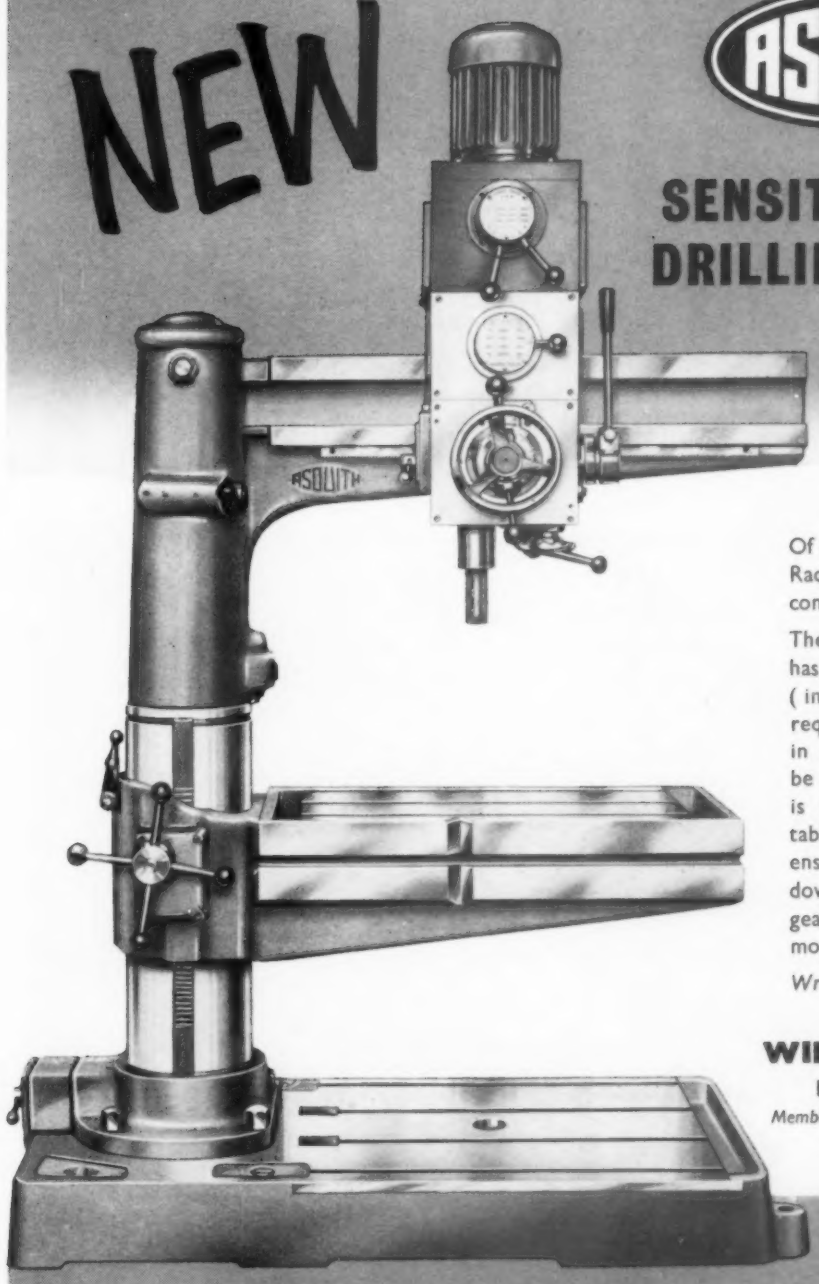

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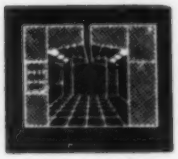

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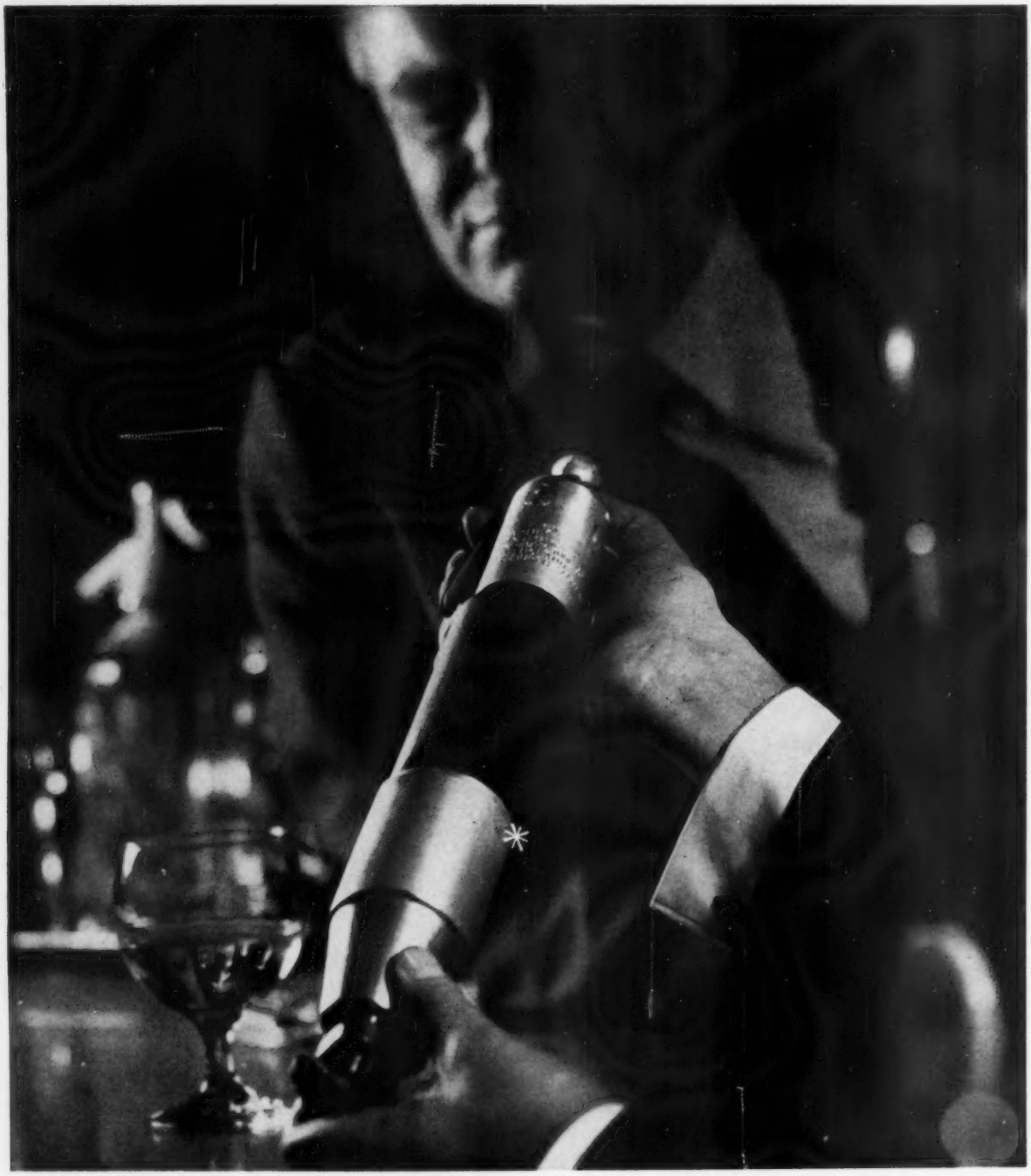

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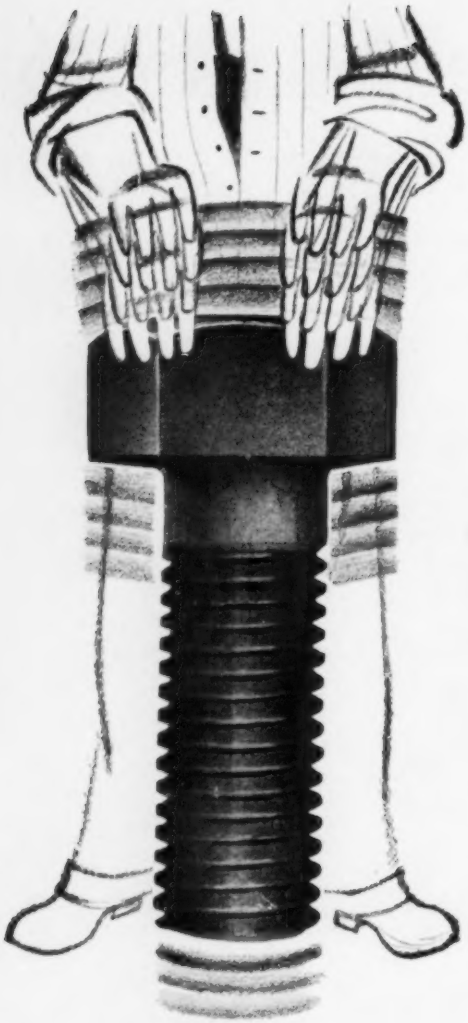

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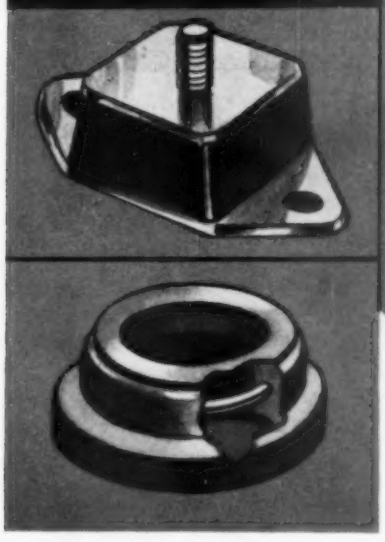

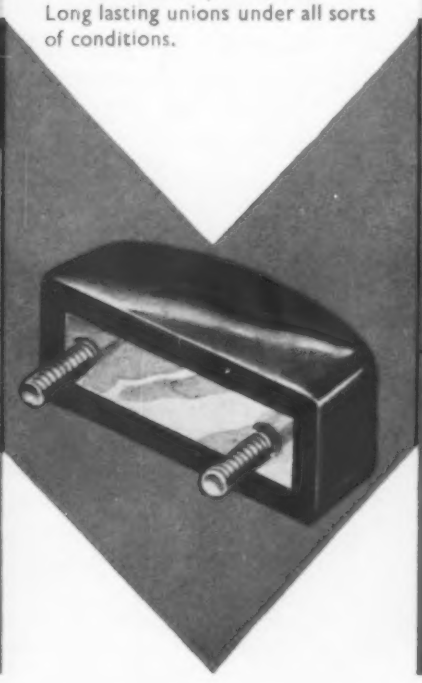

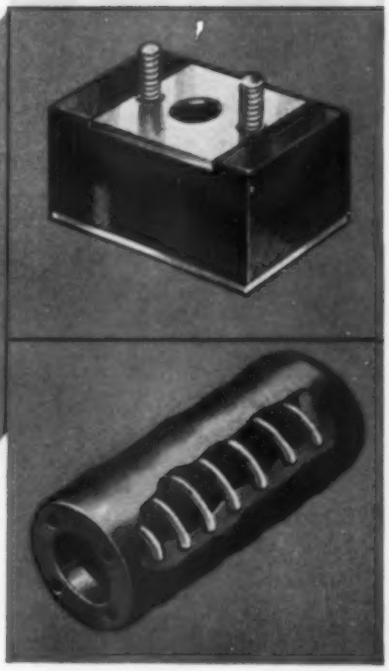

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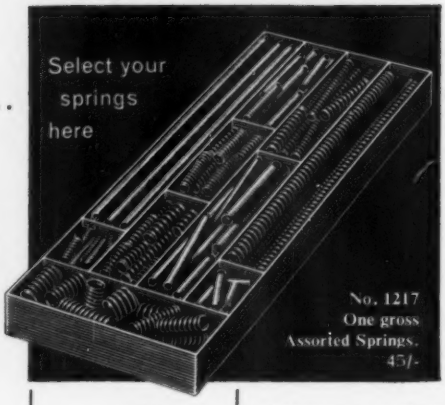

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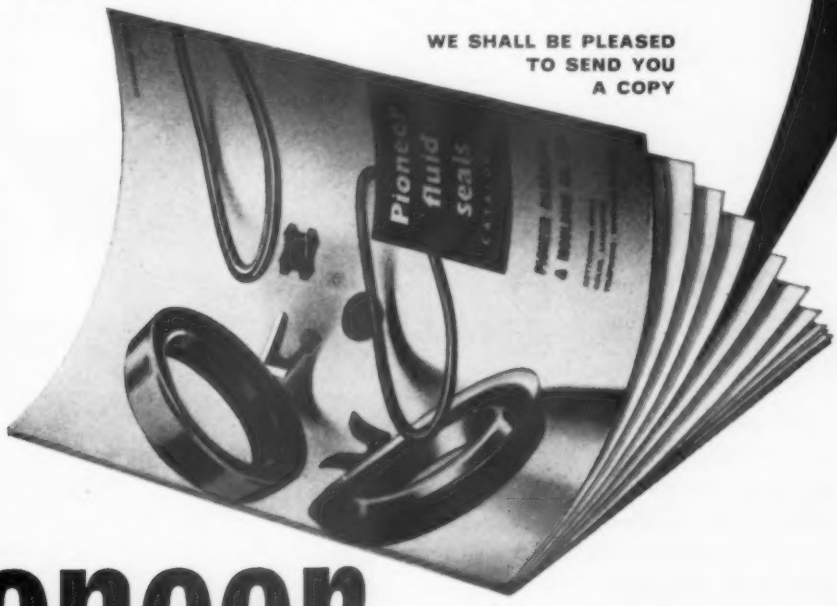

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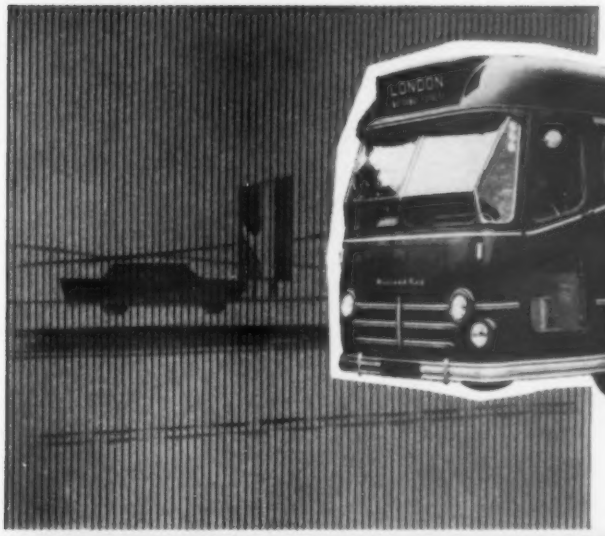

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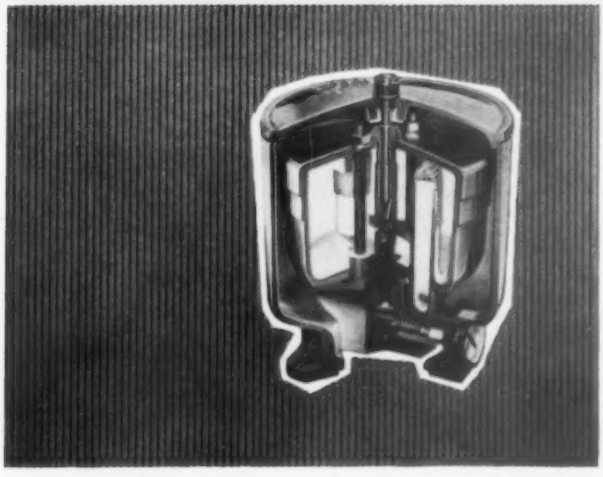

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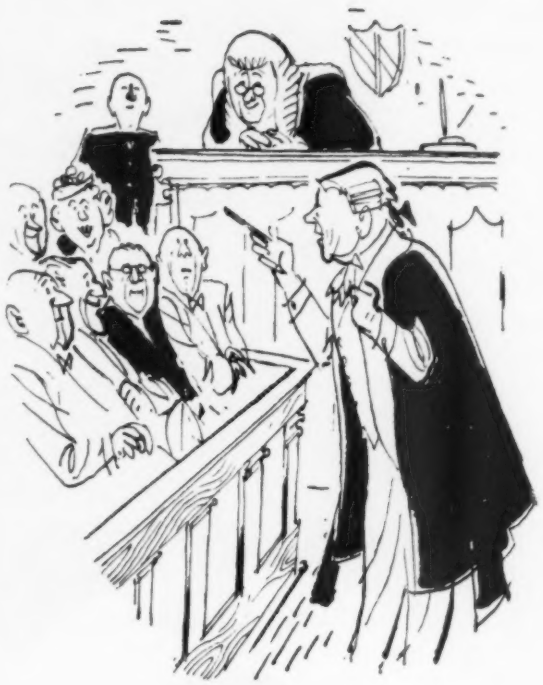

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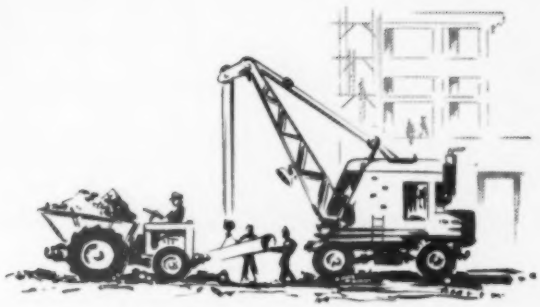

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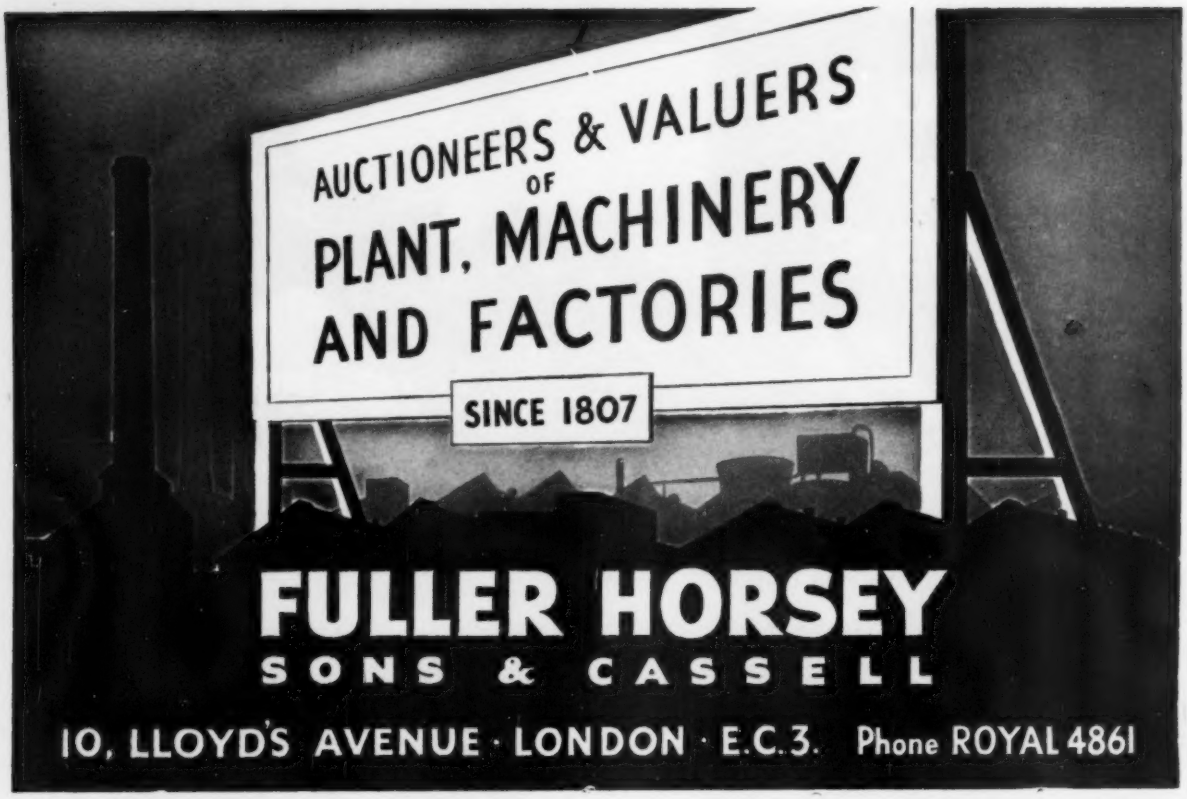

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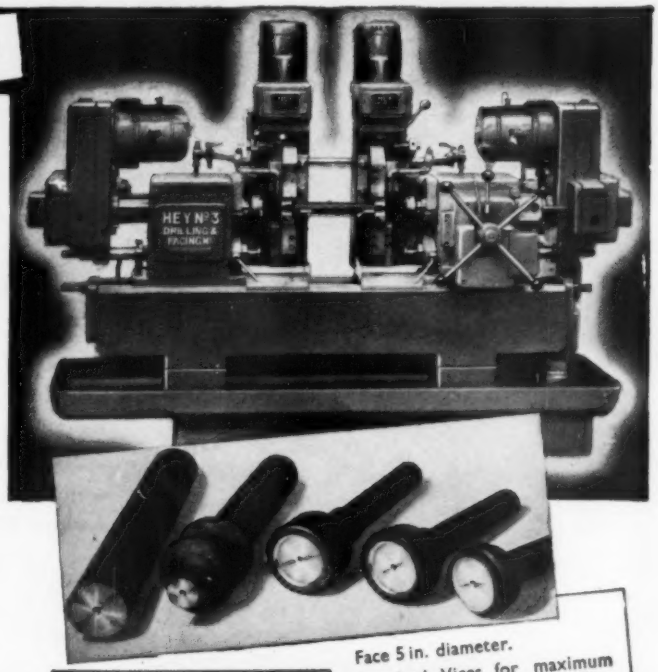

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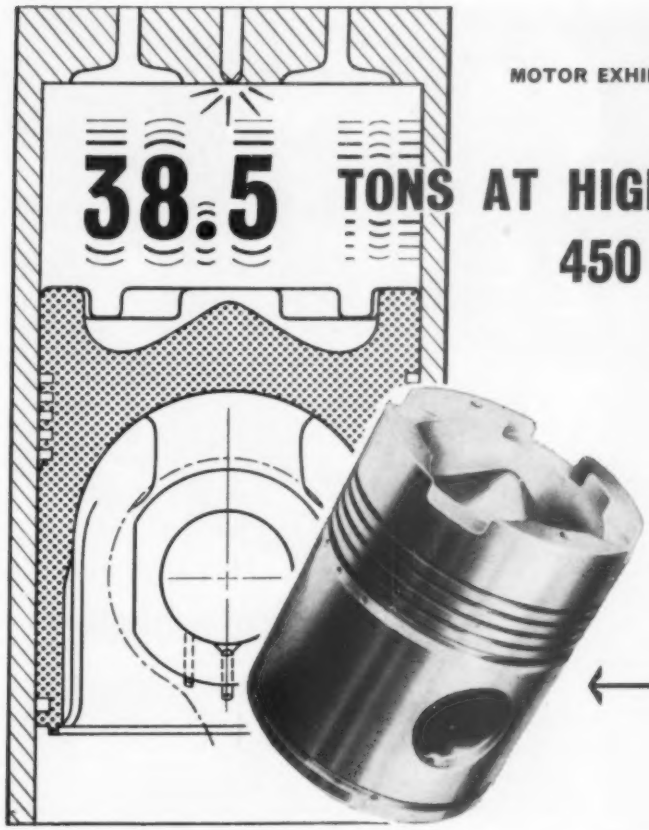

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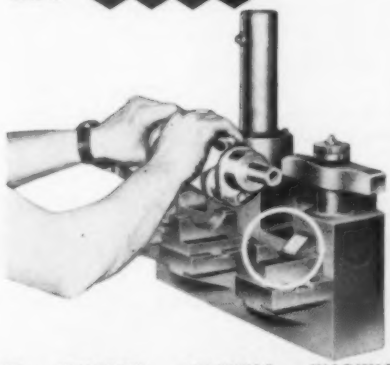

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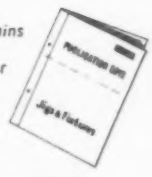

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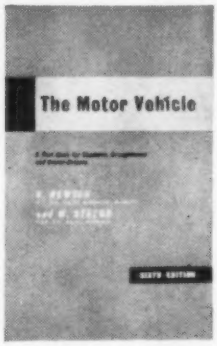

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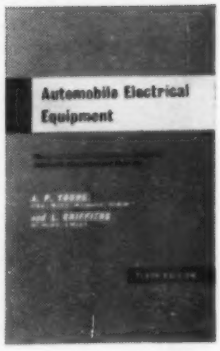

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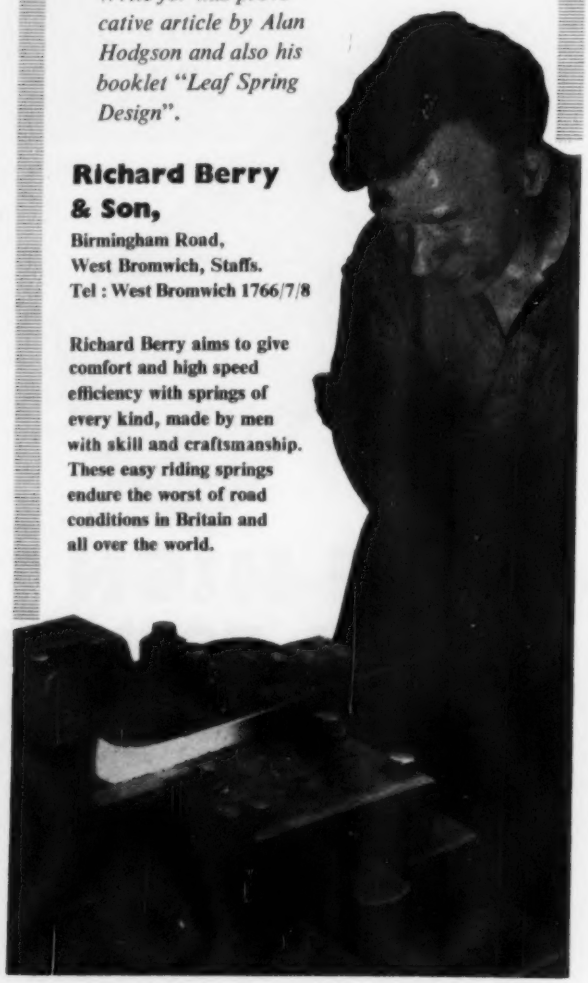

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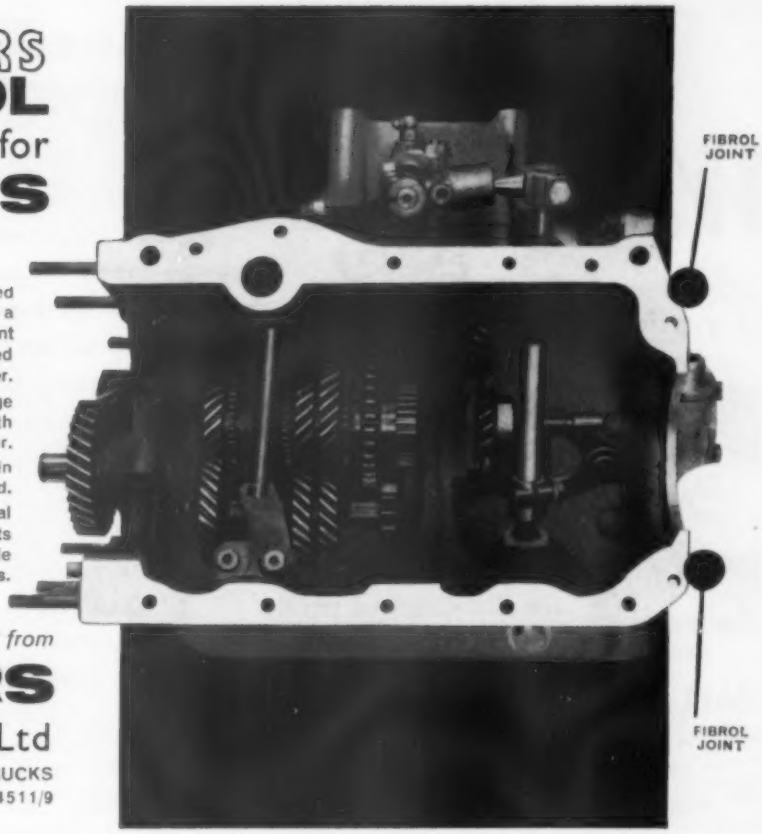

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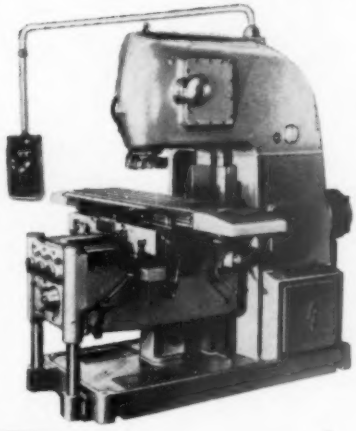

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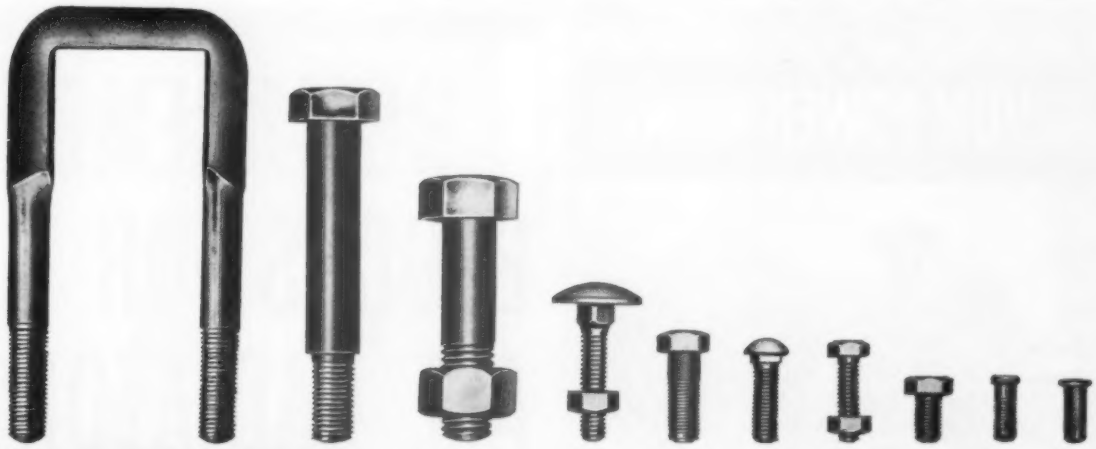

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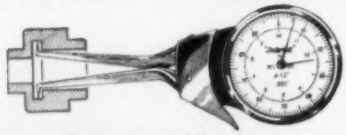

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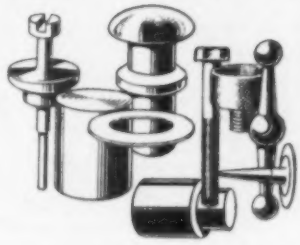

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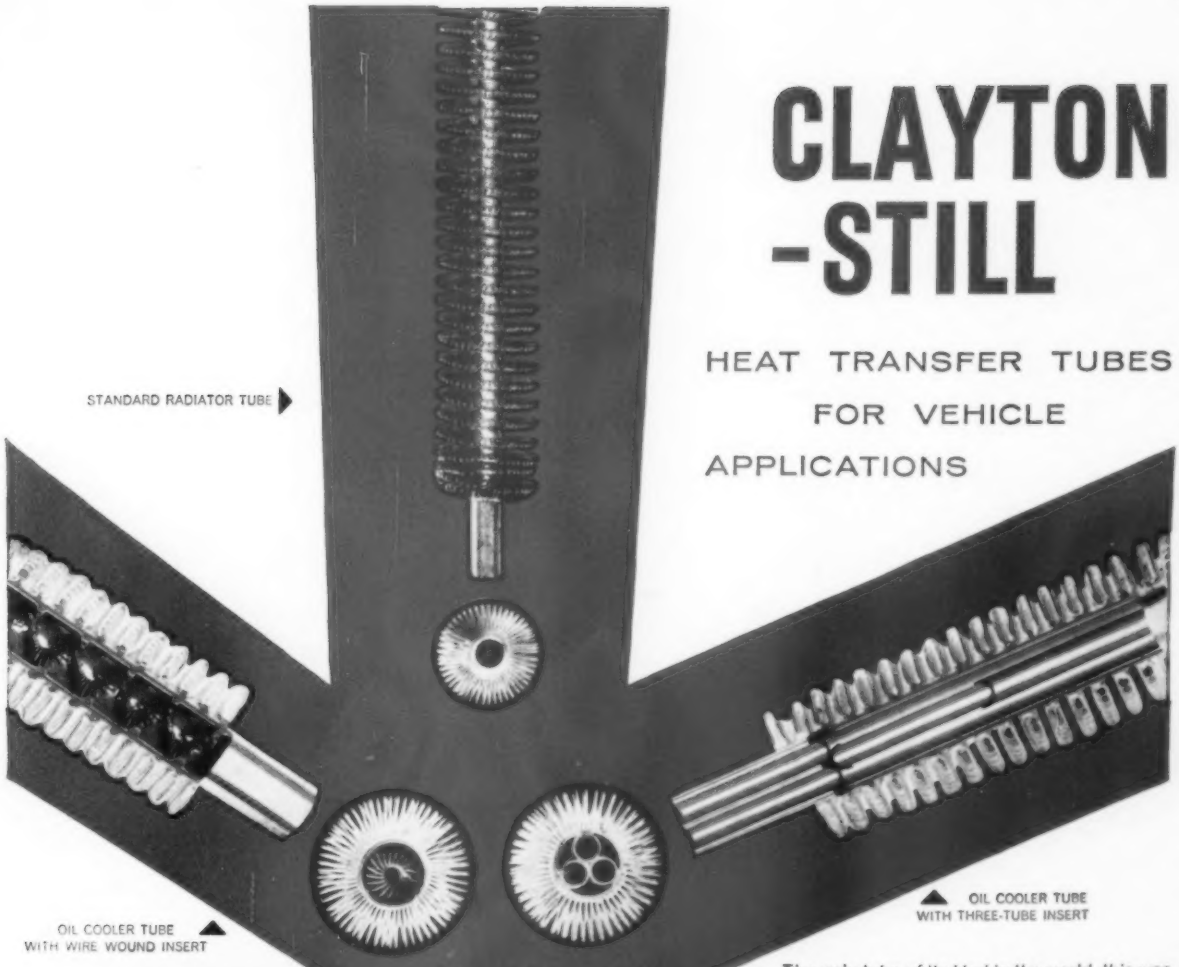

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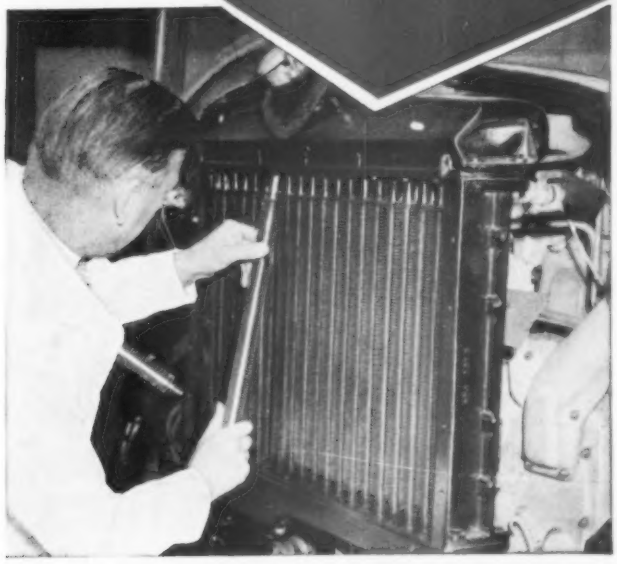

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